SOCIETAS GEOGRAPHICA FENNIAE

ACTA GEOGRAPHICA

17

SUOMEN MAANTIETEELLINEN SEURA
VIRIBVS VNITIS
GEOGRAFISKA SÄLLSKAPET I FINLAND

HELSINKI — HELSINGFORS
1963

SOCIETAS GEOGRAPHICA FENNIAE

ACTA GEOGRAPHICA

17

HELSINKI — HELSINGFORS
1963

HELSINKI—HELSINGFORS
OY TILGMANN AB
1963

ACTA GEOGRAPHICA
17

Text 127 pages, 24 figures in the text.

ACTA GEOGRAPHICA 17, N:o 1

PEHR KALM IN THE CHILTERNS

BY

W. R. MEAD

HELSINKI — HELSINGFORS
1962

CONTENTS

PRINTED BY TILGMANN
HELSINKI 1962

PEHR KALM IN THE CHILTERNS

Geography is the outcome of the thought and labours of an unknown chain of workers, continuously modified by the growth of knowledge, yet old in aim, old even in the expression of ideas that we are apt to consider most modern.

H. R. Mill, Presidential Address to Section E,
British Association, 1901.

A SENTIMENTAL JOURNEY

This is an essay about a tract of land embracing eight parishes in my home district. The parishes are located at the meeting-ground of three counties — Hertfordshire, Bedfordshire and Buckinghamshire. Their names are Aldbury, Edlesborough, Eaton Bray, Little Gaddesden, Pitstone, Studham, Totternhoe and Ivinghoe (the manor of *Ivanhoe* of Sir Walter Scott's novel). Although the tract covers less than a hundred square miles, it has a landscape varied in physical and human characteristics. Its physical variety is evident from Figures 2 and 3, which summarise the essential features of the contemporary topographical and geological maps. Figure 4 adds the details of the recently completed soil survey. The area lies at the meeting ground of chalk hills and clay vales. The hills are the Chilterns, from the 600 foot escarpment of which are commanded views across the clay lowlands to the north.

In the spring of 1748, Pehr Kalm left London (cf. Figure 1) accompanied by his assistant Lars Ljungström and spent three weeks at the village of Little Gaddesden, staying at the village inn, »The Robin Hood».[1] His observations are recorded in *An Account of a Voyage to England on his Way to America*, some 200 pages of which were either written at Little Gaddesden or re-written from notes made there. There were a number of motives for Kalm's journey to North America. Principal among them was the search for new seed materials

[1] cf. Appendix, p. 35. which gives a diary of his movements.

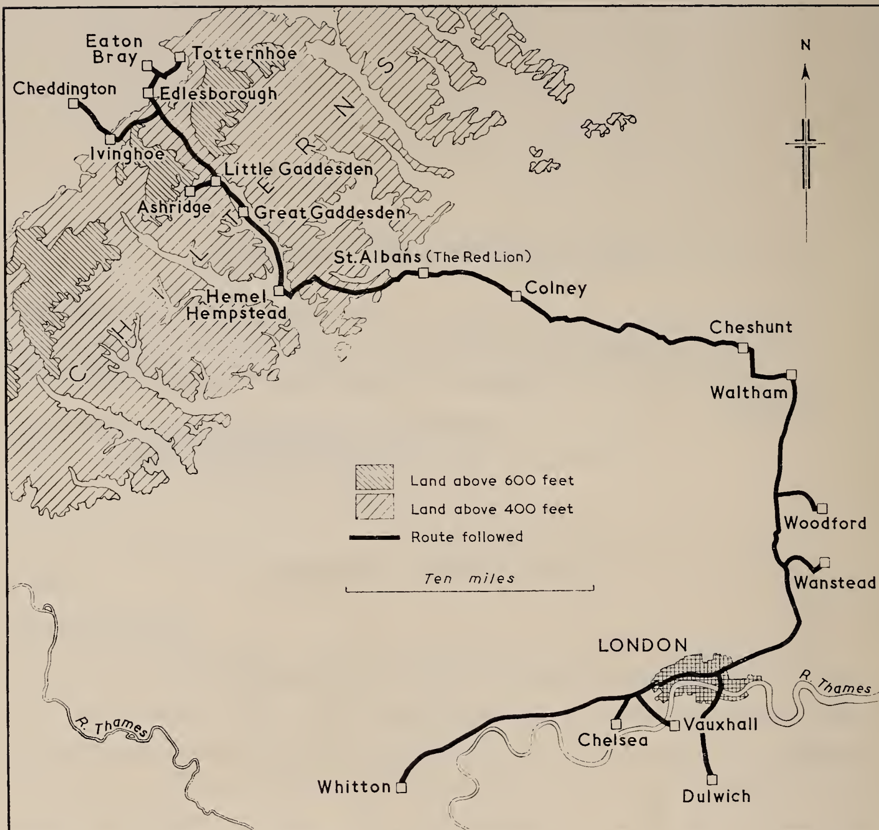


Figure 1. *The Route followed by Pehr Kalm on his Way to Little Gaddesden.*

to improve Sweden's »poor meadows, acid swamplands and dry hills». When Kalm's journey was first debated, natural scientists agreed that it should be undertaken in a land »in the same latitude as ourselves».[1] Later, the search for »*analogia situs*» was substituted for the parallel latitude.[2] Parallels of place with similar (and perhaps transferable) opportunities might be discovered in unexpected lands.

Little Gaddesden could hardly be expected to provide analogies to Sweden or Finland; and a second motive lay behind Kalm's visit. In rural Hertford-

[1] C. S. Skottsberg, ed., *Pehr Kalms brev till Friherre Sten Carl Bjelke*, Åbo, 1960.

[2] *ibid*, a letter dated April 18, 1748.

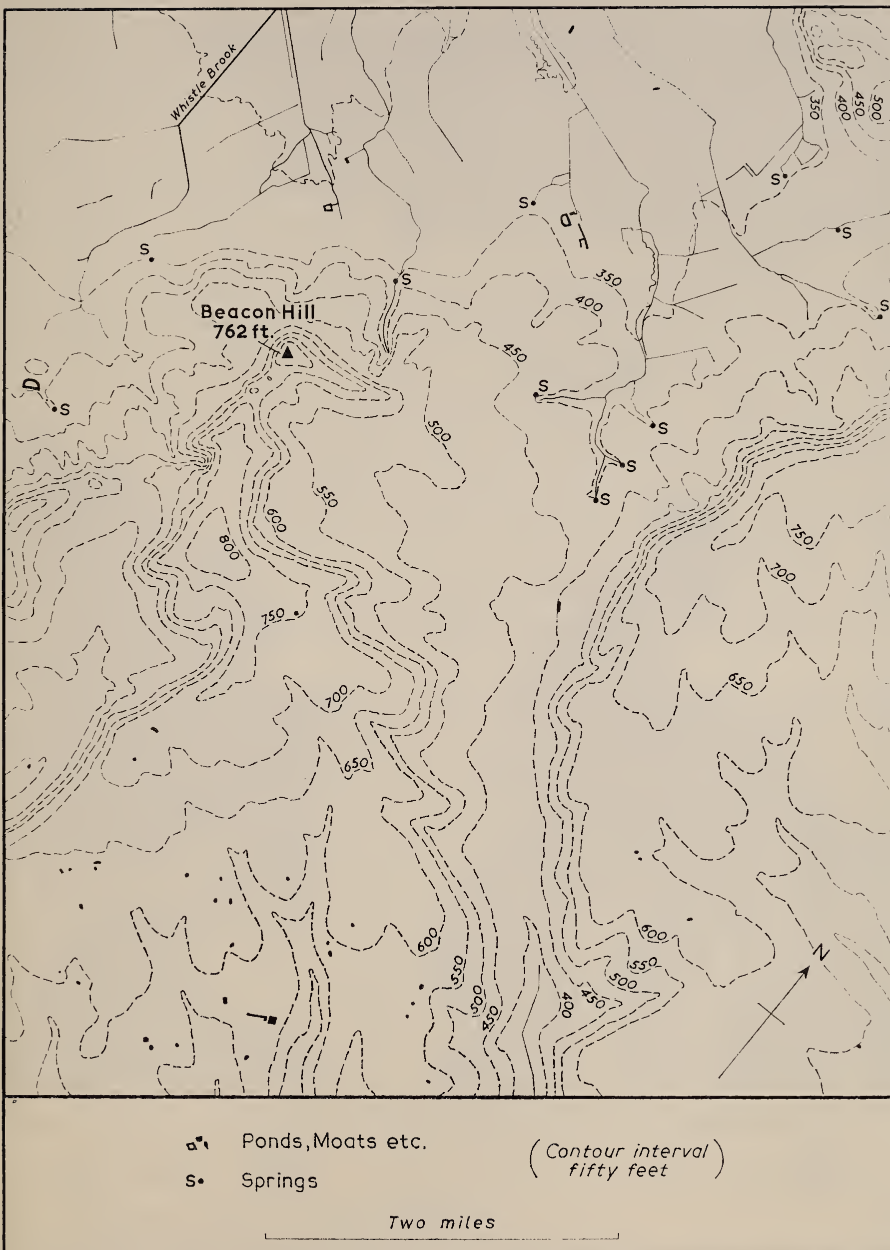


Figure 2. *Relief and Drainage of the Area visited by Pehr Kalm* (Based upon Ordnance Survey, 1:25,000.

Figure 3. *Geology of the Area visited by Pehr Kalm.* (Based principally upon Geological Survey, 1:62,500, Sheet 238.)

shire, he sought to learn more of improved farming practices and technical equipment, knowledge of which had been disseminated in Sweden through books of English husbandry. Among the most prolific of the literary husbandmen in Kalm's day was William Ellis (c. 1690—1758), of Church Farm, Little Gaddesden, whose *Chiltern and Vale Farming explained* (London, 1733) was the natural complement of Pehr Kalm's diary. Letters by Kalm to his patron, Baron Bjelke, reveal the origin of the decision to visit Ellis. In the autumn of 1747, Kalm was visiting Jacob Utfall, a merchant in Göteborg. Utfall was described by Bjelke as one »who held Ellis's writings in awe like the Holy Writ, who knew everything about Ellis's life and attitude».[1] It is likely that Kalm had familiarised himself with *Chiltern and Vale Farming* and rehearsed its technical language before he left Göteborg.[2] He had probably also seen *The Practical Farmer; or the Hertfordshire Husbandman* (London, 1732). With the detail of the literature in mind, Kalm was anxious to translate it into reality. Above all, he wanted to see the »mechanical implements for farming, ploughs, harrows etc., either in model or full scale» being used in the field, to ascertain their effectiveness for different operations and to see their performance on different kinds of soil. It was an exercise in keeping with Kalm's motto, *experimendo non conjectando*, and with Ellis's aphorism »experience (is) the only touchstone of truth.»[3]

Pehr Kalm's North American journey (*En resa till Norra Amerika*) was published in three volumes in Stockholm, dated 1753, 1761 and 1776. The visit to England was included in the third volume, which was not printed until a generation after the observations were made. The standard edition used in Finland was issued by the Swedish Literary Society in 1904.[4] The only available English translation of the journey to England is that made by the geologist 'Joseph Lucas from the Stockholm edition of 1776.[5] The original manuscript (or hand-written copy of it) is in the University Library of Helsinki and none of the printed texts accords with it.[6] In respect of Volume III, Kalm acknowledged »as regards English rural economy, I have omitted much in order that the work might not become too bulky». Examples of the omissions are found

---

[1] *ibid*, a letter dated October 13, 1747. Several of Ellis's works were among early additions to the library of the Finnish Economic Society in Åbo, cf. *Inventarium*,1800, p. 90.

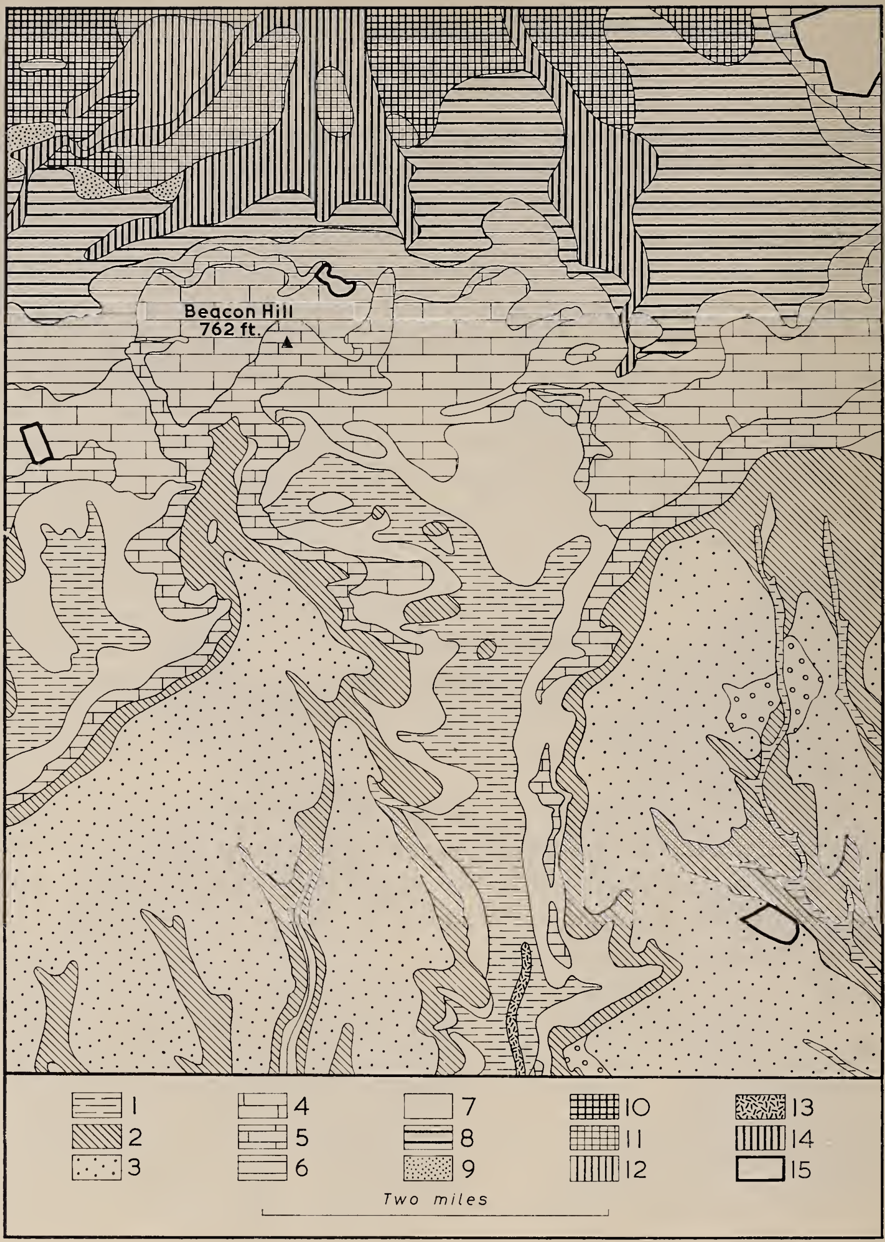
[2] cf. p. 7 below.

[3] Farriery, London, 1746 the preface.

[4] F. Elving and G. Schauman, ed., Helsingfors, 1904.

[5] London, 1892.

[6] Sections covering the English journey are in Vol. I, p. 185—300; II, p. 301—579.



1. and 2. Brown earths (sub-divided according to local series). 3. Gleyed brown earth. 4,5 and 6. Rendzina (sub-divided according to local series). 7. Brown calcareous. 8. Gley calcareous. 9. Gleyed grey siliceous. 10 and 11. Clayey gley (sub-divided according to local series). 12. Gley with clay sub-stratum. 13 and 14. Calcareous alluvial gley (subdivided according to local series).

Figure 4. *Soils of the Area visited by Pehr Kalm.* Based upon *Soil Survey of England and Wales*, Aylesbury, Sheet 238 (1961) and manuscript materials supplied by Mr. E. W. Avery and Mr. D. W. King of Rothamsted.

In the descriptions of plough construction,[1] in botanical observations[2] and in the daily weather notes. Joseph Lucas's English translation is the labour of an enthusiastic amateur rather than that of a professional translator. It is not without errors (though, in fairness, Lucas includes the Swedish of any debateable words); it partly replaces the chronological arrangement of the diary by a not entirely satisfactory chorological arrangement.

From the Lucas translation, independently of the original texts, Pehr Kalm's Chiltern journey emerges as a notebook of valuable topographical observations which is ripe for revaluation. In this essay, it is proposed to comment on the qualities of its author as a natural historian and husbandman, to summarise his view of the Chiltern scene from the *Account of His Journey*, and to complement this with a contemporary description and interpretation of the present landscape. Observations of equal merit to those of Kalm which refer to such a limited area and which are of two centuries' standing are not commonly encountered. It is a satisfying experience to follow in the footsteps of such a competent topographer and to compare past and present by reading his observations on the spot. The Chiltern tract to which Kalm may be Cicerone is not too extensive to be covered on foot and it is still sufficiently free from obstruction to be traversed on horse. These are the ways in which Kalm covered it and they are the ways in which I have followed after him. The journey is an appropriate pilgrimage for a student of Anglo-Finnish or Anglo-Swedish relations.

PEHR KALM AS A NATURAL HISTORIAN

Pehr Kalm's record reflects his time and his training. The age in which he lived moved at a slower speed and men perforce had a different relationship to and appreciation of the natural world. Writing of travellers before the days of mechanical propulsion, the essayist H. M. Tomlinson observed[3]

> »They kept next to the earth and moved about on their feet like the savages of the land. They went through each day at the pace of the shadows of the sun. This gave them the leisure necessary to examine the nature of whatever took their attention, the pause to think it over and thus an opportunity to make shrewd guesses at the implication of things.»

---

[1] Mss. Vol. II, p. 325—38, e.g. Mr. Ellis's swing plough, the two-wheeled Hertfordshire plough, the broad lands plough, the wheat seed plough, the foot plough.

[2] Mss. Vol. II, p. 416—24; 448—51; 484—90.

[3] An essay on early travellers, *John o' London's Weekly*, 6/6/1951.

His words were true of Kalm. Nor must one forget the speed of movement of the pen (or rather the quill) over paper. During the spell of three weeks Kalm made generous notes. Some must have been written by candle light, for the days are not all that long in early April and his accounts show that bills for candles were heavy.

For the historical geographer, Kalm's record is the more valuable because it represents the detached observation of an outsider. In his appreciation of Kalm as a traveller, Martti Kerkkonen has written[1]

> »Two worlds face each other in the traveller's mind: the one in which he is moving and the one which he has left behind but which for all that he carries with him.»

The outsider recorded features and described processes that the native took for granted. Repetitious though they may be, perhaps the best descriptions of planting a hedgerow, or of thatching and pegging a rick have been provided by Kalm. At the same time he reflected upon the similarities of features with those of other places in his experience. The ridged lands of Ivinghoe recalled those of Närike and Westmanland; the arable fields near Dagnall resembled »the arable plain of Upland». Other features were given point by being contrasted with those of Kalm's homeland.

Kalm had been trained in the school of Linnaeus and had travelled in the company of the master. As a thirty-year old scientist he still communicated the enthusiasm of discipleship, while the discipline of Linnaeus is reflected both in the assiduously cultivated art of observation and the speed with which he recorded his impressions. The freshness in much of Kalm's writing is inseparable from the fact that he was on the spot when he wrote it. Kalm would have subscribed to the view of the English poet Thomas Gray that »a word or two written upon the spot is worth a cartload of recollections».[2] Nowhere is this more evident than when Kalm is in his Theophrastian mood. As a botanist, he delighted in the flora of the chalkland, and listed it in the part-Swedish, part-Latin nomenclature of his day. He described how he teased out 21 different specimens and placed in order of abundance the dried flora from one of the Duke of Bridgewater's hay lathes. In a hay rick at Hudnall he counted 28 different plants. He is the sort of man who would have found the proverbial needle in the haystack.

---

[1] Peter Kalm's North American Journey, *Studia Historica*, I, Helsinki, 1959, p. 75.

[2] Thomas Gray (1716—1771) was much associated with the southern Chilterns as well as having interests in both Nordic literature and the work of Linnaeus.

This is no place to analyse Kalm's literary style, but the impact of the journal gains much from it. Any English appraisal of it could not fail to pay tribute to an attention to detail reminiscent of Jonathan Swift's *Gulliver's Travels.* The precision with which Kalm describes strange techniques and unfamiliar objects repeats that with which the Lilliputians drew up their inventory of the contents of Lemuel Gulliver's pockets. A judicious use of arithmetic adds to the precision. The ages of a 30 year old holly tree and a 156 year old beech are counted from their sap rings: the breadth of ridgelands must be paced out. Nor was Kalm to give loose translations of English rural terminology.[1] Before he left Sweden, he wrote of grappling with the *terminus technicis* of Ellis. He tried to anticipate the characteristics of the »ridgelands» (ridge arable »the same as Westmanland»); »ridge-acre lands» (or »acre lands laid in ridges») and »bouts» (formed by a ploughman driving his team down one way with a plough and back to turn a furrow over the same piece of ground). When dealing with the Little Gaddesden scene, Kalm used the terms »common field» and »inclosures» (*inclosurerna,* in the plural), »farm» and »farmer» (which were translated *gård* and *landtman* when his work was printed). Place-names were subject to variation in spelling, e.g. Edgeborough (still encountered locally as the pronunciation of Edlesborough) for Edlesborough, Tatanol for Totternhoe, Ivingo (a rendering of Ivinghoe found on some earlier maps) and Carrington (which somewhat confused Joseph Lucas, but above which is written Cheddington in the original manuscript).[2]

The virtues of Kalm as a field worker — art in observation, fluency in expression and skill in interpretation — make his Chiltern notes a model worthy of study. Kalm emerges as an empiricist in the best Linnean tradition — noting by day, measuring, counting, sketching (regrettably not maps), questioning the local inhabitants, sifting his evidence, interpreting, speculating, writing by night. The result is more than a patient record, for Kalm was also considering the cause and effect of features he observed, and transfering his experience mentally to a home scene which he hoped to ameliorate. In this sense, independently of others, Kalm's English journey is a document that mirrors the working of the mind of a natural husbandman in the age of enlightenment.

---

[1] A most valuable series of references to technical terms and their translation is included in Sven Dahl, Strip fields and enclosure in Sweden, *Scandinavian Economic History Review,* IX, 1. 1960.

[2] Vol. I, p. 281. A loose slip of paper in the manuscript and bearing a short list of place-names in Kalm's hand-writing suggests that they may have been deliberately copied down for reference.

KALM'S APPRECIATION OF THE FEATURES OF THE LAND

Kalm had no detailed map of the area which he visited. Figures 2 and 3 show the form and structure of a land which he sought to describe and explain in words. Kalm re-iterated the underlying distinction between the Chiltern Hills and the Vale, chalk country and non-chalk country. The »continuous succession of undulations», with related hills »long-sloping down into dales» composed a dip-slope which contrasted with the »frighteningly high hills» of the scarp (Ivinghoe Beacon, Steps Hill, Duncombe Hill). North of the hills, the gentle slopes of the Vale were »so slight that (they) scarcely depart from a horizontal plane».

Chalk revealed itself in a number of ways. It was white upon the surface as a constituent of the soil, it was exposed in pits, it was mined as freestone. Sometimes, Kalm postulated »entire hills which consist only of chalk». There were different kinds of chalk — softer species, churned up along the tracks, which looked like »lime-mortar» and clung to shoes and the wheels of carts in the same way; broken layers, which were brought up by the plough and had a rubbly appearance in exposures; more resistant bands at lower horizons, locally named »Hurlock». The only other stones found in the area were conglomerated gravels, or »puddingstones», and flint. Flint sometimes lay upon the fields »so thickly that many would wonder how crops get room to take root». Surface deposits were of variable depth. Their thickness was observed in pits, in plough furrows and in ditches. It was also communicated by well-diggers. The chalk upland was variously covered by clay deposits (clay-with-flints). In one pit on the dip-slope flank, Kalm measured 4'3" of brick-coloured surface deposits. In the adjacent valley of the river Gade, there were spreads of »flint gravel or coarse sand», yielding a rust-coloured soil (in which Kalm sought unavailingly for grains of quartz). Well-diggers told him that chalk was found at depths of 14—20' beneath the gravel. Soil colour and texture changed north of the hill country. Kalm observed a well-defined junction between the dark grey soils and the whitish soils along the east-west course of a little brook north of Ivinghoe. Land to the north was frequently low-lying and wet, with rushes growing even in the ploughed fields. At Cheddington, there was »gunpowder black» earth reminiscent of the mosslands of Kalm's home country.

The origin and lithological variation of the chalk were problems that Kalm reviewed against the background of mid-eighteenth century theories of changing land and sea level debated at Upsala and Åbo, and the concept of deposition as a process in the building of land surfaces. Fossil evidence provided him with »an unfailing sign that the chalk formation had in former times been sea».

Cockle, mussel and oyster shells were all embedded in rocks that he saw. Variations in the hardness of the chalk also needed explanation. They were believed to result from »the difference of the time and ages since the chalk formation has come to stand above water or under it». The dales might formerly have stood below water with »rain and water floods» washing surface deposits into them from the adjacent hills and giving their soils the same ochrous tinge. Might not the same processes eventually give to the white soils of Ivinghoe the same reddish-yellow hue as those in the Gade valley below Little Gaddesden.

The most impressive of the chalk rocks was the freestone seen in the mines and pits of Totternhoe. A section in the hillside provided Kalm with a profile of the lower chalk — one foot of top soil, 24 feet of »ordinary chalk» yielding increasingly to »hurlock . . . so hard that one can write with it», and finally to the freestone. Adits reached the principal freestone workings, at levels 120 feet or more below the surface of the hill, and penetrated 660 feet into its side. The freestone, cracked and fissured into perpendicularly placed »cubes and oblongs», hardened on exposure to the air. Embedded in it were balls of iron pyrites, sometimes called »cows' gold». Kalm also found pyrites in fields both around Edlesborough and Little Gaddesden, which confirmed the common origin of the different types of chalk country.

> May not the chalk and freestone differ if only in the degree of hardness and development, according as they lie nearer the surface or deeper down? . . . May not the chalk sometimes, perhaps, change first to Hurlock and afterwards to freestone or *vice versa?*

While the freestone was the most impressive rock of the chalk series, the residual flints were the most perplexing. Immediately Kalm began to move around Little Gaddesden he was aware of them, sometimes

> in such abundance that the earth could scarcely be seen, both light and dark in colour, mostly as small as a closed fist.

On closer acquaintance with the chalk, he became aware that different types of chalk were distinguishable by the presence or absence of flints. Kalm observed that the deeper a pit was dug the fewer flints there appeared to be; while the harder kinds of chalk, e.g. Hurlock, produced »scarcely any flint fragments». There were also »many chalk pits on whose sides were scarcely any flints, while . . . the ploughed fields and the soil above were full of them». It was an old wives' tale that »chalk exposed to sun and rain hardened into flint», and Kalm observed chalk weathering into a fine meal when used as dressing in the fields. Admittedly, lumps of chalk carted to the fields might

themselves contain flints, but these were generally small in size compared with the frequently large, strangely-shaped fragments which Kalm encountered in such abundance.

The chalk was notable for its 'rarity of surface water'. Streams were small by comparison with the major relief, and this was especially evident in the case of the river Gade. By contrast, it was possible to make regular references to underground water.[1] The depths of wells were noted, from a few feet in the valleys to several fathoms (275 ft.) below Ashridge House. Springs and their related features were recorded, e.g. the 60—70 foot entrenchment formed by the brook issuing from Boxhead spring. The chalk country was also credited with »land springs» (as they were termed by the local inhabitants) — patches of pitch black, boggy soil some six feet in diameter. Among artificial features, ponds were ubiquitous. Most villages had a pond »where the people took their water and the cattle slaked their thirst»: so had most pasture fields.

Kalm only made one sortie into the vale — following the Cheddington road; but his impressions of the physical contrasts into the hill country would have been amply supplemented by *Chiltern and Vale Farming*. William Ellis devoted generous space to the contrasts in soil types, with all their practical consequences for the farmer. The »low ground» of the Vale was characterised by a variety of clays, common to all of which was a »sour surly nature caused by (their) intense cold aqueous and marly parts». The »high ground» of the Chilterns was predominantly of light, chalky or loamy soils. Chiltern and Vale soils differed in their stone content. Vale farmers were »generally strangers to a very stone, while we in the upper grounds, in many places, are forced to plough but little else». A direct consequence of this was that »five pounds will go as far in a smith's bill in the Vale as fifteen will go in the Chiltern land». In addition to the cost of broken plough shares, the expense of tillage was increased by dressings for the »hungry, lean, high and dry ground». Yet both Chiltern and Vale soils had their virtues. Two ploughings on the chalk served the purpose of four elsewhere, and a greater diversity of implements could be used than on the heavier soils of the Vale, but the Vale »required less art and dressing to obtain a crop than the Chilterns», once the land was »ridged up» for drainage.

Two final points may be made about Kalm's appreciation of the physical geography of the Chiltern and Vale. First, it sharpened his curiosity about the processes of geological change. It was a part of this training as a natural

---

[1] Joseph Lucas, translator of Kalm's English journey, was himself a specialist in 'hydro-geology' and worked on the Chiltern aquafers.

scientist that he should ponder the agents of change in the physical landscape just as it was his purpose, for social and economic reasons, to promote change in the human landscape. He had no Old Testament illusions about the immutability of the hills. »The chalk hills . . . have not been as they are since the world's beginning», he declared. Secondly, he was confronted with change taking place in a different environment from that of his home country. It was change in a land of younger and less resistant rock forms. »Chalk is a child of later times» was the metaphor used by Kalm of this gentler geological scene.

A CONTEMPORARY APPRECIATION OF THE FEATURES OF THE LAND

The outlines of the hills and even the contours of their lesser relief have been modified only fractionally since Kalm's time; but in the interval there has been much patient enquiry into the evolution of the chalk landscape. The problems with which it confronts the physical geographer are rooted in the same features as then, but new forms of evidence supplement the simple *heterogenea* with which Kalm testified and new realms of explanation have been opened up. In the long chronology of denudation which has shaped the face of Kalm's corner of England, not only has the role of different agencies to be assessed, but the different roles of the same agencies at different times has to be debated.

During the last century, the nature of Chiltern geology has been rendered explicit (cf. Figures 3 and 9). Although he expressed it in other words, Kalm was aware of the banding of chalk as well as of minor cracks in its structure. Three bands of hard rock are identified today — the Chalk Rock in the Upper Chalk, the Melbourn rock in the Middle Chalk and the Totternhoe stone in the Lower Chalk. These introduce differential resistence to erosion upon exposure as well as giving rise to springs at different levels. Joints in the structure of the chalk help to explain the patterns assumed by the distinctive coombes of the scarp.

But these structural features can only partly explain the physical landscape. The position, form and origin of the northward-facing scarp with its related valley features raise the principal problems. In the theories that are concerned with the evolution of the scarp, the agency of water plays a persistent, if changing role. No single theory suffices to explain origins and no single process can account for the prevailing forms. Kalm's lobe of hill country with its convexo-concave slopes, scarp headlands, embayed valley entrances, foothill ap-

proaches, lesser coombes, and apron of Vale land was born in a Cretaceous sea and rippled into shape in the Alpine orogeny, only to be worn to a surface of low relief. With his lively interest in the rise and fall of water level, Kalm would have been impressed by the concept of subsequent marine transgression, the waves of which etched cliffs, deposited beaches high on the dip-slope of the hills and probably trimmed coombes and embayments in their phase of retreat. Standing in the graveyard where William Ellis is buried, one may detect the degraded 600 ft. Calabrian shore-line in the Whipsnade dip-slope beyond the wind gap of the Gade.

Such marine processes, however, do not account for the primary form of the land and it is here that debate is most lively. Among explanations, the hypothesis of scarp retreat, formulated by C. C. Fagg, is widely quoted.[1] Assume a recession or wearing away of the scarp face. This will lower the level of springs at the spring-line between the Chalk and the Gault. If the related lowering of the water table proceeds more quickly than the down-cutting of the valleys on the dip-slope, they will tend to dry up, leaving coombes, wind gaps and other waterless features of such an area as the Chilterns.

A second hypothesis, assuming a higher water table with related spring sapping and stream erosion, has been conceived by B. W. Sparks and W. V. Lewis in their explanation of kindred scarp face coombes to the east of the Ivinghoe area.[2] Such a theory, postulating a wetter climatic phase, might go far towards explaining the lesser features such as Incombe Hole (which Kalm doubtless saw).

A third theory, initiated by C. Reid, looks to a colder climatic episode (or episodes) and places the chalk hills in the tundra zone of the Pleistocene glaciation.[3] Assume the periglacial conditions familiar to parts of Kalm's home country transferred to the Chilterns with resulting impermeability of the chalk due to sub-soil freezing. A powerful springtime run-off might then result in periodic scouring of the relatively soft surface. Given such conditions, much valley infill might be attributed to meltwater and to slumping effects. Meltwater might also explain lakes which appear to have occupied the northern approaches to the Tring and Gade embayments.

---

[1] The Recession of the Chalk Escarpment, *Transactions of the Croydon Natural History and Scientific Society*, 9, 93—112, 1923 and The Coombes and Embayments of the Chiltern Escarpment, *Ibid.*, 117—131, 1954.

[2] Escarpment dry Valleys in Pegsdon, Hertfordshire, *Proceedings of the Geologists' Association*, 68, 26—38, 1957.

[3] On the Origin of dry Chalk Valleys and Coombe Rock, *Quarterly Journal of the Geological Society*, 43, 364—73, 1887.

Each theory makes a contribution to the fuller understanding of the area, but none is entirely satisfying. Both the massive scale of the sculpturing processes and the problems of an acceptable time scale into which they can be fitted challenge the complete acceptability of any one explanation. Moreover, there remains another highly contentious issue — the origin of the clay-with-flints blanket. Earlier suggestions that it might be attributed simply to the large scale wasting of chalk through solution are largely discounted. The most that would be admitted is that the materials loosely defined as clay-with-flints are of several origins — not least resulting from the re-sorting of Tertiary beds through postglacial solifluction.[1]

With maps to hand as well as the land and with the means of visualising this area in its broader context, the successors of Kalm have not been idle in their attempts to explain this piece of country. Wider and deeper issues are raised by the few square miles of hill and vale than could be dreamed of in Kalm's eighteenth century philosophies. In the explanation of such issues lie the answers to the geomorphological evolution of south-eastern England at large[2].

KALM'S APPRECIATION OF THE EIGHTEENTH CENTURY LANDSCAPE

Although Kalm was fascinated by the form of the land, the way in which men used the land and the means which they employed in their use of it were of greater concern to him. His observations fall into four groups. First, there are those relating to the contrasts between the Chiltern tract and Kalm's home land. Secondly, there are those that spring from the fact that this was a countryside of considerable contrast within itself. Diversity of relief, rock and soil called for a diversity of human adjustments. Thirdly, it was evident to Kalm that there was a diversity imposed by man upon the land as well as that born of nature, for three different cultural landscapes — each of which was interlocked with the other — met here. Kalm was unaware of the way in which these diverse landscapes reflected differing historical evolutions; but in a fourth group of observations, he showed awareness of the different scales of operation associated with their particular systems.

[1] All of these issues are reviewed in B. W. Sparks, *Geomorphology*, London, 1960. With his interest in plants, Kalm would have been especially fascinated by the analysis of pollen from deep borings peripheral to the chalkland, with a view to confirming the cycle of vegetation in the last inter-glacial period.

[2] S. W. Wooldridge and D. L. Linton, *Structure, Surface and Drainage in South-east England*, London, 1955.

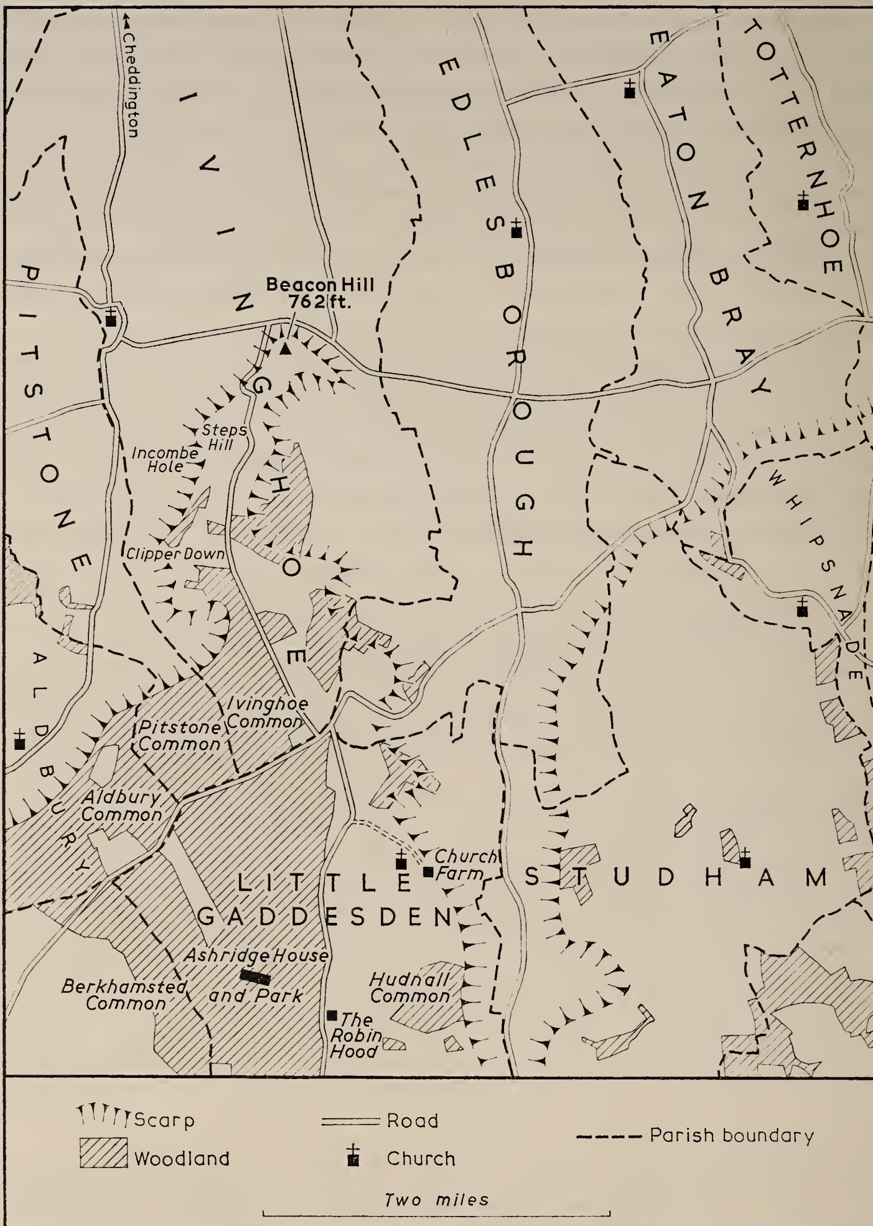


Figure 5. *The Parishes of the Area visited by Pehr Kalm.* The principal place names mentioned by Kalm are included. The distribution of woodland and commonland, and the outlines of parish boundaries are drawn from the contemporary map.

By comparison with Finland, the greater part of both Chiltern and Vale land was distinguished by open vistas, deciduous trees, absence of surface water, easily tilled soils, and long-established settlement. Flora and fauna indicated the clemency of the climate. Beach, oak, lime, maple, elm, hornbeam, wild cherry, poplar, ash, willow and hazel formed woodlands and groves. William Ellis explained their particular distributions. Oaks and elms thrived on the clays around the »champain fields». Beech was no good on the »spewy and wet soils of the Vale»; but on the hills, »where a wood of oak has been felled, a wood of beech has spontaneously succeeded . . . beech grows too fast the oak's pace.»[1] Ivy climbed as much as sixty feet up their trunks: moss was surprisingly abundant about them. Conifers only grew where planted ornamentally. The thorn shrubs — hawthorn, sloe, dog rose and blackberry — composed the hedgerows and, together with gorse, invaded the commonlands. Lesser fauna also reflected a mild climate — snails and hedgehogs, rabbits and hares, moles (beneath their abundant hills) and worms (below their numberless casts). Squirrels and deer haunted the woods, gulls followed the ploughman, and the cuckoo arrived on the eve of Kalm's departure (April 14).

Besides being a countryside of considerable natural diversity, this was also a land of evident plenty. For Kalm, plenty was expressed chiefly in the comparatively rich and well-integrated crop and animal husbandry. To come to a country where grass grew more prolifically than Kalm had ever seen it before was an experience in itself. »Grass is a part of botany in which I delight», he once confessed. It was the diversity of species that he found so exciting. Cultivated grasses were grown in the meadows, which were manured in the same way as arable land. Grass grew in a seemingly natural state upon the chalk downland.[2]

The variety of crops, their modes of cultivation and differing yields were all subjects of scrutiny. On the drier soils, wheat (usually autumn-sown) and oats (principally for horses) were found. At Little Gaddesden, 25 bushels of wheat per acre out of two bushels sown was a fair crop. Spring-sown barley was widely cultivated. It yielded ten bushels for one sown at Ivinghoe. Rye, sown in the autumn for sheep to eat green in the spring, was subsequently ploughed in as a green manure. Legumes included »abundant pease», clover (usually sown with other crops and rarely harvested for more than two years), sainfoin (which might be left down for twenty years), »maple peas» (for pig fodder), beans, vetches (commonly cut as a feed for horses in May) and tares. Turnips

[1] *Chiltern and Vale Farming*, op. cit., p. 91 et seq.

[2] cf. A. S. WATT, The Vegetation of the Chiltern Hills, *Journal of Ecology*, 22, 1934, 230—70; 445—507.

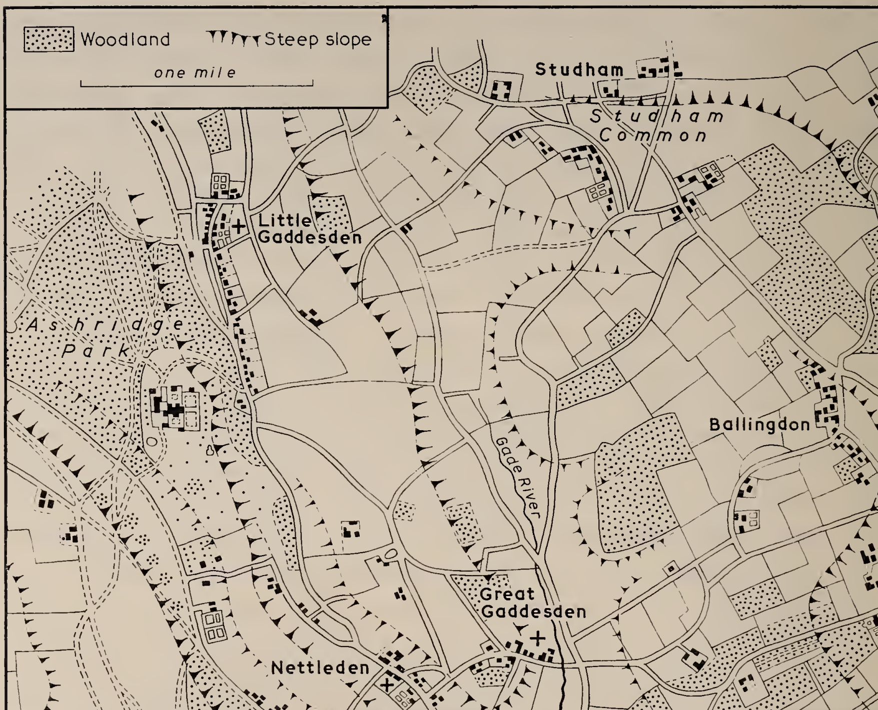


Figure 6. *Little Gaddesden and District as presented by A. Dury and J. Andrews, A Topographical Map of Hertfordshire, London, 1766.* This is the largest scale map available for the area from the period of Kalm's visit.

were grown in abundance for human consumption, as well as for cows, sheep and swine. Carefully thinned and hoed, they grew to »a larger size than a man's head». Potatoes were both a garden and field crop. Kitchen gardens were objects of much care; their produce ranged from humble carrot, parsnip and cabbage to espaliered peach, apricot and morello cherries.

Kalm was much interested in the various manures which kept the soils in good heart. Animal manure was usually applied to arable land every 1—3 years, depending on the industry of the farmer or the availability of supply. As a litter in farmyard and byre, bracken was used as well as straw. Straw was also strewn on roads and brushed up as a manure. Chalk was dug from pits and applied one in 16—20 years. Ashes and burnt lime were believed valuable. In the Vale, ditch earth was distributed. Less common was the use on the lower chalk wheatlands of soot and rags (both from London over thirty miles away,

and both still employed in the same way a century after Kalm's visit). Elaborate methods of sheep-folding for manuring arable lands were also practised.

Sheep were the most common grazing animals. Their predominance was closely related to the nature of grazing conditions in the hill country, and to the conditions of ownership in the Vale. William Ellis confirmed that the high and dry places were best for sheep, and Kalm commented on the risk of foot rot even in the Vale. Since farmers willingly paid to have sheep folded on their arable, landless labourers could keep a flock with profit. Cattle, used principally for local domestic purposes, were more modest in numbers, and around Little Gaddesden most farmers only had three or four. Some cattle were grazed seasonally in the open fields of the Vale, with cowherds controlling them.[1] Swine fed on the beech mast and acorns were gathered for them. Deer also grazed in and around Ashridge Park.

Preparation of the seed bed differed between different places and for different purposes. In the grain fields of Little Gaddesden, the »stitches» were commonly four-furrow, about two feet broad, with an intervening water furrow six inches deep and a foot wide. The furrows were drawn from the highest part of the field to the lowest. Such four-furrow land was also called two-boutland. Elsewhere, »broadcast land» laid out in flat, ploughed plots, was used for peas, clover and sainfoin. North of Ivinghoe, the fields were heaped into great ridges, from twenty to more than thirty feet broad, the crest of a ridge standing up to 2'6" above the furrow bottoms and a little furrow supported at its crest. The ridged lands continued all the way to Cheddington. In the open fields, narrow balks sometimes divided a farmer's strips; but unenclosed fields were without balks. From two to six horses were harnessed to the ploughs, depending on the texture of the soil. Kalm was impressed by the practice of rotating meadow and arable *per ordinem successionis* in the enclosed farming country of Little Gaddesden, and correspondingly critical of the open field fallow.

Familiar and unfamiliar equipment was employed side by side in the working of the land. Ploughs took pride of place (cf. p. 1 above) in the implements described. They were generally adapted to particular types of land. Thus, the two-wheeled double Hertfordshire plough was designed for loose and sandy soils, but not for clay and hard lands, its two plough shares calling for three pairs of horses. Familiar harrows (subject to much damage in the »flint-filled earth») were complemented by unfamiliar rollers. Foddering gave rise to a

---

[1] The church records at Pitstone contain reports of parish meetings for the management of grazing in its open fields held until the time of its enclosure (1856).

number of devices — from thatched hayricks sitting on stone staddles, through tubular arrangements in hay lathes to prevent spontaneous combustion, to a variety of hay racks in the fields for controlled feeding. In the woodlands of Ashridge, saw pits as alternative to sawyers' tressles, struck Kalm as a useful idea, and he drew a sketch of crampons for climbing trees.

All these activities took place against three different cultural landscapes, which partly conformed to physical differences in the countryside, but were partly imposed upon them. They were also conducted on units of land which differed greatly in their size and form. Kalm's headquarters were among the old-enclosed lands of the chalk dip-slope, where the formal unit of the countryside was the rectangular hedged field and the unitary farm was the dominant functional unit. But the dip-slope also had unenclosed stretches. These were the commonlands which, as can be seen from Figures 5 were shared by the adjacent Vale settlements, the historical boundaries of whose parishes thrust purposefully southwards into the hill country. Timber trees, scrub, bracken and heather grew on them. Kalm observed that the commonlands, with their rights of grazing and gathering, could be important for a landless labourer in such a parish as Ivinghoe. Sheep were pastured on them: bracken and furze were collected from them.

Two different types of open country lay north of the dip-slope *bocage*. First, there were the open grazings of the chalk scarp — grass, gorse, partly bracken and scrub-clad, with their adjacent big unbounded arable fields on the Lower Chalk bench. This was virtually treeless as well as hedgeless country. The second type of open country was the unenclosed Vale, where an »open field» system of husbandry prevailed, centred on nucleated villages with their small »closes» (enclosed fields) and gardens compact about them. Such settlements as Ivinghoe and Edlesborough, located at the meeting ground of the two different types of country, shared in both systems. Kalm's impression of the Vale was also of its exposure and bleakness, with »cold winds playing over the large open fields». In contrast to properties on the dip slope, those in the Vale were much fragmented and scattered in furlongs over an extensive area. Figure 7 shows a sample property from the time. »A map of His Grace the Duke of Bridgewater's estate in the counties of Buckingham and Hartford» by G. Grey of Lancaster (1762) also included isolated strips owned in the furlongs of the Vale. Owner-farming was probably more frequent in the open fields of the Vale than in the hill country. The extensive parkland belonging to the Bridgewater estate was a typical Chiltern feature. Tenantry prevailed among the farmers. Around Little Gaddesden, Kalm noted that »few of the farmers own the farm they live upon».

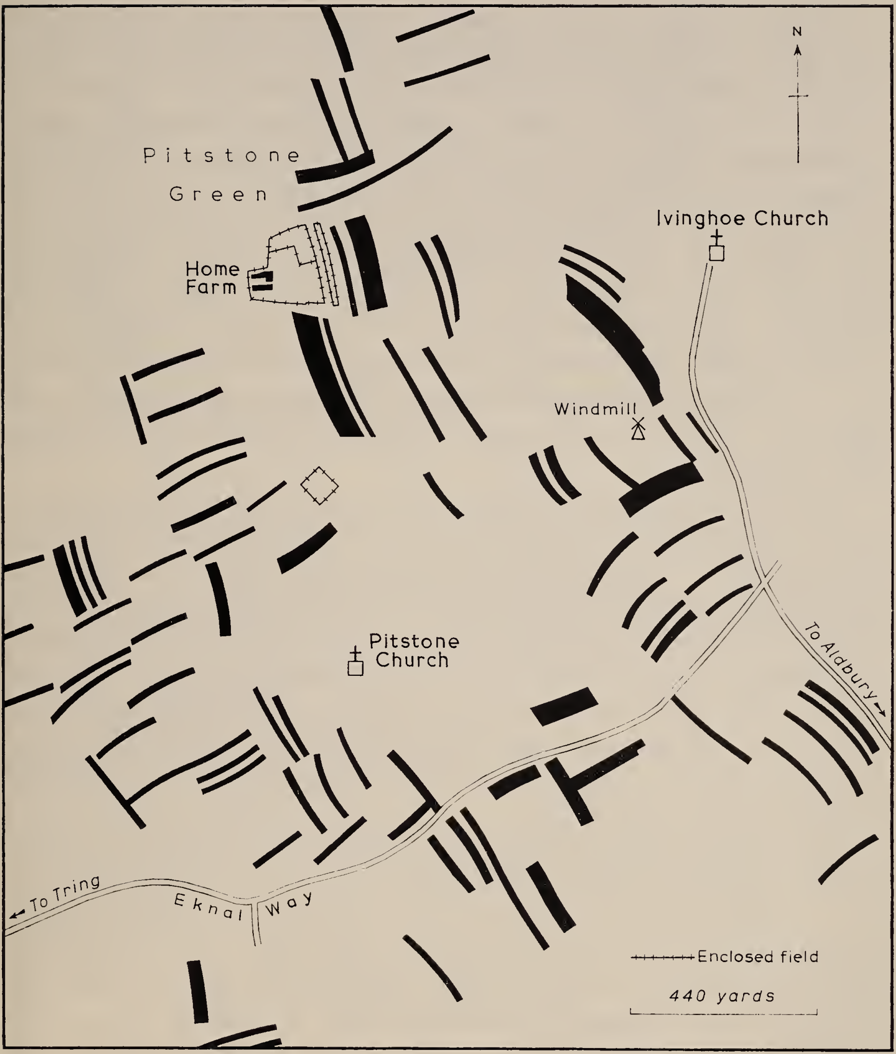


Figure 7. »*A farm lying in the several parishes of Pitstone and Marsworth in the County of Bucks and of Tring and Aldbury in the County of Herts, being the estate of Mrs. Ann Astley, surveyed by Thos. and Wm. Wilkinson, 1755*». The constituents of a farm in the area visited by Kalm give some indication of land holding conditions in the Vale before enclosure. Five outlying strips were also held in Tring Mead. (Ashridge Collection, Hertfordshire County Record Office, 170/56975).

Pehr Kalm was especially sensitive to the contrasting systems of land management, both because he could see the unitary holding and fragmented holding operating side by side in this tract of country, and because talk of enclosure was in the air. He visited England on the eve of the great period of Parliamentary Enclosure, which was to change the face of the Vale lands. Moreover, he left for England at the same time as a minor army of land measurers set about re-organising the Swedo-Finnish farm scene through *Storskifte* (Finnish: *Isojako*), which was the counterpart of English Parliamentary Enclosure. Kalm was opposed to the open field system, because it restricted a farmer's opportunity and ingenuity. The range of crops was more limited between Ivinghoe and Cheddington than around Little Gaddesden. In the Vale, every farmer had to accommodate his crops to those of his neighbours, cattle and sheep could not be satisfactorily fattened, and fallow might be necessary every other year.

In this country of timber shortage, enclosures were bounded by hedgerows and Kalm was interested in their preparation. Nurserymen provided the thorn seedlings, which farmers bought by their thousands, set 3″ apart on a bank together with hedgerow trees, and protected by a fence or dead hedge for two or three years until they were large enough to resist the depredations of animals. Maintenance of hedges, usually in late autumn or early spring, was equally important and plashing took place every nine years. In this process the stems were partly severed, bent over, and bound to stakes with bramble cords. Plashing encouraged a thick impenetrable growth of thorny scrub at the base of the hedge.

Antiquity of settlement and a well-provisioned countryside were evident in the impressive stone and flint churches, of which he saw at least six. From some of them Kalm deduced that the freestone had been worked for nearly a thousand years. Dwellings were commonly brick-built; sometimes cross-timbered, sometimes employing lath daubed with clay as an infill, and tile-roofed. Among local kilns for brick and tile were those of Ashridge. Freestone was worked into windows, lintels, arches, pillars and fireplaces; flint was used especially for foundations and as a walling material. Timber dwellings were uncommon, but there were oak-boarded out-buildings. Indoors, flooring was of imported deal boards. The steeply-pitched house roofs were often straw-thatched, as were the hay ricks.

It was early spring when Kalm came to Little Gaddesden, but still sufficiently cold for him to be made aware of fuel problems. Timber was a »precious treasure». For home and kiln use men collected stumps and roots of felled trees; hedgerow twigs, trimmings and rootlets not thicker than a quill

Figure 8. *The Area as represented on the first Drawings of the Ordnance Survey.* This map is based upon four of the Ordnance Survey drawings (scale 2 inches to 1 mile): — No, 150 (surveyed 1806—7), 155 (1813), 148 (1810) and 232 south (1815). It illustrates the rapid progress of enclosure in the years subsequent to Kalm's visit.

pen; the remains of »dead fences» used for protecting young hedges; bracken, gorse, wheat straw, sawdust (sold by the bushel) and even the fallen leaves of autumn. It was ironical that this strict economy prevailed beside the »curse of the open fireplace».

Men lived principally from farming, but they had related and supplementary earnings. There were woodworkers — sawyers (also stripping oak bark for the tanners) and carpenters, wheel-wrights and plowrights (making mouldboards from ash and beech). Quarry-men, masons, millers (employing both wind and water) and smiths were familiar to Kalm in contrast to the unfamiliar lime-burners, maltsters, brewers and bakers (»a baker in every village» and »fresh bread every day»). Division of labour was different from that at home. Women undertook no farm work, while »weaving and spinning (were) a more than rare thing, because their manufacturers save them from the necessity of such». But straw-plaiting and straw-hat making were widely pursued. Waggonners, their wheels rutting highways »up to two inches deep» in winter, transported merchantable goods. For regional specialisation had already established itself in England and its effects were self-evident.

> The wholesome custom is . . . that every district lays itself out for something particular . . . to cultivate that which will thrive and develop there best . . . They thus sell their own ware and buy what they themselves have not.

In general, Kalm viewed this corner of the Chilterns as a country of increment rather than of hardship, where the seasons permitted more relaxed rhythms of labour than in his homeland, and where transport and markets facilitated specialisation. Tamed and trim between the wilder and shaggier worlds from which Kalm came and to which he was going, the countryside seemed to him a virtual garden in which »neither nature nor art and diligence had been spared anything».

THE CONTEMPORARY HUMAN LANDSCAPE[1]

A third of the countryside observed by Kalm in 1748 has changed relatively little. Documentary evidence for measuring the extent of change is scanty. From the mid-eighteenth century there are occasional estate materials, a few

---

[1] Features of the area are also summarised in J. T. Coppock, *The Chilterns* (British Landscape Through Maps, No. 4), Sheffield 1962.

farm maps, and very limited Parliamentary Enclosure Award maps.[2] Subsequent sources for this area include the first topographic maps of the Ordnance Survey (1806—15) as shown in Figure 8, the maps of the tithe survey (1841—53) and the materials of the population census (decennially after 1801). The relevant sheets of the Geological Survey date from the mid 1830's; while the soil survey (partly unpublished) belongs to the last decade. Although the headquarters of the Meteorological Office are adjacent to Beacon Hill, there is little precise knowledge of the local climates of the area. Variation in altitude and aspect produce considerable differences in temperature, rainfall and wind conditions within the limited hundred square miles.

Figure 9 summarises the principal characteristics noted by Kalm against geological and pedological profiles. It also provides a time chart of the principal events that have affected the evolution of the area since Kalm's day. The diagram partly explains why the degree of visible change has been greater in the Vale, on the lower Chalk foothills and in their embayments, than on the high chalk lands. Principal among the reasons have been the revolution in land holding brought about by enclosure and the introduction of new mechanical techniques. New forms of transport, seeking out the lower altitude of the adjacent Tring gap affected the life of the locality, by transforming the prices of farm produce, fuel and constructional materials. The Grand Junction Canal, following the contour to the north-west of Ivinghoe on its way to the Midlands, was opened in 1805. The London & Birmingham Railway followed a closely parallel course in the late 1830's.

Agriculture continues to dominate the landscape. Farmland is generally employed more intensively and more economically than 200 years ago. Fallow has been virtually eliminated; mixed husbandry prevails. The frontier of cultivation returned to areas from which it retreated in the later nineteenth century, and much formly rough-grazed land has been transformed. Sown grasses, for example, have effectively replaced »natural» grass on the south flanks of Beacon Hill: kale may be cultivated to the rim of Incombe Hole and almost to the crest of Steps Hill. In the Vale, the arable husbandry associated with the open field system was succeeded by a prolonged grassland cycle before the current phase of arable practice. Rotation grass and fodder crops predominate in the rectangular, hedged, arable fields, where in June the yellow

[2] Final Enclosure Awards in the group of parishes were dated Little Gaddesden (1846), Studham (1847, 1867), Pitstone (1856), Cheddington (1857), Eaton Bray (1860), Edlesborough (1865), Totternhoe (1891) cf. *Hertfordshire Archaeological Journal*, 1947, p. 18—31; W. E. Tate, *A Hand List of Buckinghamshire Enclosure Acts and Awards*, Aylesbury, 1946.

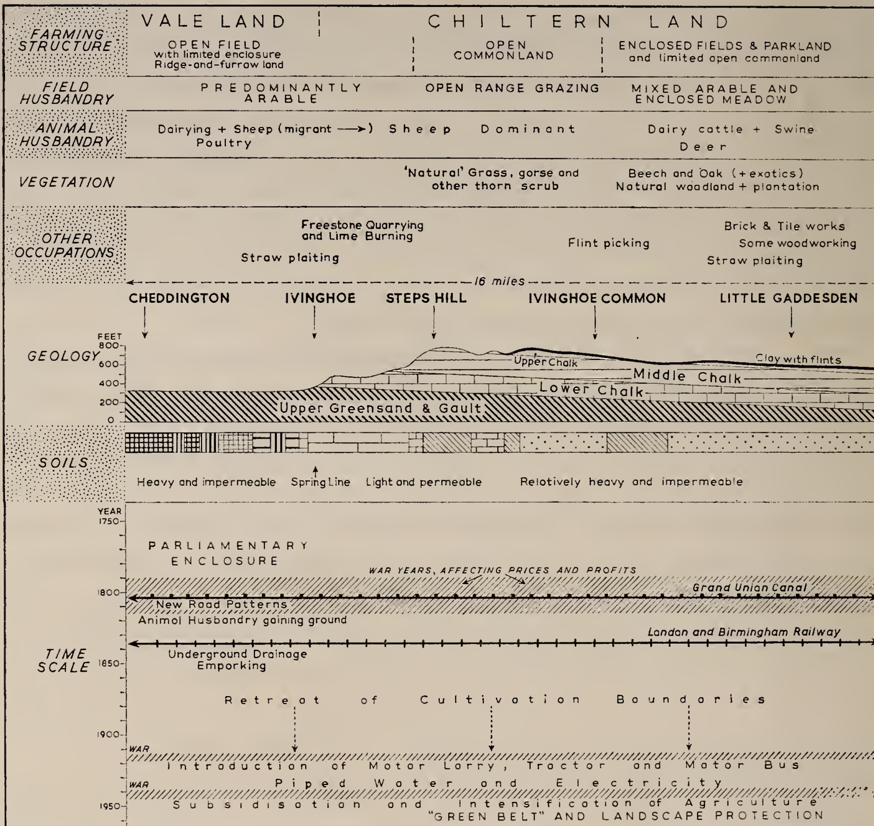


Figure 9. *A Transect Diagram of the Chiltern and Vale Land.* Above the geological section, the diagram shows the economy of the area as summarised from Kalm's observations: below the section, the chief factors that have affected the development of the area are summarised chronologically.

of buttercups (*Ranunculus* sp.) distinguishes the old permanent grasslands from the temporary leys. On the chalk, cultivated land supports a simple flora by comparison with the rich diversity of plants that compose the »natural» vegetation.

The land is more heavily stocked than in Kalm's time. Dairy herds are common to both the champain lands of the Vale, and the farms of the Chilterns. Sheep are ubiquitous; but most evident on the chalk scarplands, where several flocks numbering several hundreds are carefully grazed rotationally on large fields enclosed by post and wire fences. Poultry stocks are also large. Com-

Figure 10. *Contemporary Field Boundaries in the Area visited by Pehr Kalm*
The map indicates the nature and length of the different types of field boundary employed today. The costs of maintenance can be readily appreciated.
(Based on a field survey undertaken by Mr. N. C. Furley, of University College, London).

mercial orchards have been introduced since Kalm's time, but they are in retreat today. Plum orchards are most common and they pick out the better drained, less frosty sites along the foothills. Totternhoe has extensive glasshouses.

The extent of woodland (cf. Figure 5) on the chalk is probably much the same as two hundred years ago, though planting and felling have caused local changes in distribution. The limited conifer plantations are lost in extensive beech and oak stands. A richly exotic flora from the four corners of the world has accommodated itself to parks and gardens. There are parts of Ashridge park in which Mediterranean, Asian and American trees and shrubs combine to give an entirely alien appearance to the landscape. The park is an arboretum which would have thrilled Kalm and which has come into being over the last 150 years. Some Mediterranean species, especially the rhodedendron and sweet chestnut, have escaped from the park to naturalise themselves. As a result of the considerable number of hedgerow trees and coppices, the Vale gives the illusion of an area which has been cleared from mature deciduous woodland. Brief though the period may be since Parliamentary Enclosure, its »champain lands» have been transformed into a continuation of the Chiltern *bocage* and they display a state of repose contrasting with the *perpetuum mobile* prevailing within the open fields.

Bricks and mortar have only spread to a limited extent over the land since Kalm's time. The Icknield Way apart, this is a country of byways rather than highways. Housing commonly shows a ribbon development along them and Ivinghoe provides a good example. In Totternhoe and Edlesborough, a more elaborate road network has encouraged more scattered growth of new housing. Little Gaddesden retains its linear form — with intakes of private development around the margins of Ashridge Park indicating the converse of eighteenth century emparking. Electricity, piped water, and rising living standards which have placed an automobile within the reach of most families, have stabilised rural population numbers, bringing in newcomers as much as they have drawn out the native element. From Ivinghoe and Edlesborough many people make a journey to work, for in adjacent parishes, large cement works have developed during the last generation. Their smoke-plumed chimneys are inescapable and north-west winds may carry their distinctive odour even to Little Gaddesden. Daily commuting to larger towns means that the occupation structure of Little Gaddesden is fundamentally different from that of Kalm's day; while week-end commuting also promotes the conversion of rural housing. The principal contrasts between 1748 and 1962 are the result of the new accessibility of the area and the new approach to the use of the land. The

new accessibility has brought it into the orbit of London, has converted it into »Green Belt» country and has called for its consequent protection. Much of the parkland and open downland of the Chiltern half of the tract is already owned publically through the National Trust. At Whipsnade, above Studham, the country estate of London's zoological gardens provides another pleasure ground set aside from private development. Acquisition of estates by hobby farmers has done much to improve as well as to protect the countryside, though public access to it may have been partly restricted as a result. The »Kalm country», as one of the easternmost limbs of the Chiltern Hills, is currently considered for protection under the provisions of the National Park and Access to the Countryside Act (1947). Such a status is indicative of the emphasis placed upon the amenity value of the hill country. Difference in amenity value is one of the new distinctions between Chilterns and Vale, both of which reflect in their prosperous husbandry the variety of supports enjoyed by the farming community.

THE ENDS OF THE EARTH

There are many divisions in the world of geographers. Not least is the antipathy between those who till a plot in their home area and those who cultivate an interest in distant places. As a churchman who aspired to a bishopric in an age of reason, Pehr Kalm must have known his *Book of Proverbs*. It would not have been beyond him to take as his sermon the text that »the eyes of the fool are on the ends of the earth». Yet no eighteenth century geographer (and Kalm wrote of himself as a geographer, albeit »a poor one») would have argued more strongly that acquaintance with the ends of the earth was frequently the best approach to an understanding of his home plot. It is a paradox that, as a young man, Kalm wrote to his patron Baron Bjelke, »no one should write about his own home district».

The name of Kalm made no real impact upon the scientific world of England until Johan Rheinhold Forster and his son translated the North American Journey. On its publication in Warrington (1770—1771), the *Critical Review*[1] proclaimed

> The time will surely come when these lands which brought forth the Goths and Vandals, shall lay claim to the palm of Europe's most civilised nations in knowledge.

---

[1] London, July—August, 1771, p. 39.

The Chiltern journey, a by-product of the North American journey, made its modest contribution to the improvement of husbandry in Kalm's home country. The record of the journey also retains a continuing relevance for those who live in the eight parishes that it covered. In the first place, it deepens the appreciation of the locality by recording aspects of its earlier form. Secondly, lineaments of the past in the present landscape are momentarily sharpened when the observations of a visitor from a couple of hundred years ago are still apposite. The broad »fossil» ridges that Kalm measured in fields below Ivinghoe village may still be paced out. The leggy box trees that the Duke of Bridgewater caused to be planted for London's turners may still be seen. Kalm's hostelry has become a private residence, Robin Hood Cottage; while William Ellis's reconstructed Church Farm is the home of a retired Anglo-Swedish industrialist. Thirdly, the record is the more appealing; because it is analytical as well as descriptive. With apologies to Ellis, Kalm's record might have been sub-titled »Chiltern and Vale explained».

Pehr Kalm journeyed to seek new ideas capable of transplantation to Finland and Sweden. A latter-day traveller from his homeland would encounter pleasant ironies as he followed in the footsteps. Within the compass of a day's walk from Little Gaddesden, he might observe a scatter of Scandinavian innovations which have been introduced to improve Chiltern and Vale husbandry. They would range from mechanical equipment to till the land, through seed materials born of such breeding stations as Svalöv and Weibullsholm, to processes to treat farm products. »When the Swedish (Finnish) peasant begins to employ all the thoughtfulness and industry in the fields that the Englishman uses», Kalm wrote to Per Elvius (24/3/1748), »then he will be able to sell more grain to the Englishman than the Englishman to him». If the word 'grain' be given a metaphorical interpretation, he sells substantially more. And there is abundant evidence of commercial invasion of the villages in this Chiltern tract by the products of Scandinavia's farm, forest and factory.

The Chiltern journey of Pehr Kalm was a scientific and practical journey; this essay is in the nature of a sentimental journey. Perhaps the youthful Kalm was right in warning a man off his home ground, for it is charged with too many emotional overtones. »Le paysage, c'est un état de l'âme». The geographer as artist might agree with Henri Amiel. As scientist, he would conform to the approach of Kalm in his maturity that the countryside exists for the constant exercise of the intellect.

Appendix

A Diary of Kalm's movements around Little Gaddesden in 1748

March 25	From St. Albans to Little Gaddesden.
26	In Little Gaddesden.
27	To Church Farm, Little Gaddesden, to visit William Ellis.
March 28—April 1	In Little Gaddesden.
April 2	To Ashridge Park.
3—4	In Little Gaddesden.
5	To Ivinghoe and on towards Cheddington.
6—7	To Dagnall, Eaton Bray, Totternhoe and Edlesborough.
8	Another visit to William Ellis.
9	Around Hudnall.
10—13	In Little Gaddesden.
14	Discussion on farm implements and evening with farmers at »The Robin Hood», Little Gaddesden.
15	To Woodford in Essex.

ACKNOWLEDGMENTS

There is an extensive bibliography about Pehr Kalm and his work, and much of it is incorporated in M. Kerkkonen, *Peter Kalm's North American Journey, Studia Historica*, I, Helsinki, 1959. In this essay, references have been restricted to those items of direct relevance to the text. There is only one English appraisal of Kalm. It is by Vicars Bell, a local historian of Little Gaddesden, who sets Kalm side by side with William Ellis in his book *To meet Mr. Ellis* (London, 1956).

In the preparation of this paper, I am indebted to many friends. My colleagues Dr. E. H. Brown, Dr. J. T. Coppock and Mr. H. C. Prince have made valuable comments on the text. Mr. E. W. Avery and Mr. D. W. King of Rothamsted Experimental Station, have helped to complete Figure 4 from their original manuscript survey. Mr. N. C. Furley (University College, London) has provided material for Figure 10. Dr. H. Wallace (British Museum Map Room), Mr. E. J. Davis (Buckinghamshire County Archive) and Mr. J. R. W. Whitfield (Hertfordshire County Record Office) have all facilitated access to their collections. Mr. Vicars Bell (the present churchwarden of Little Gaddesden) has revealed the treasures of his parish chest. Last, but no means least, I am grateful to Mr. John Bryant of University College London, who has drawn the maps and diagrams.

ACTA GEOGRAPHICA 17 : 2

A COMPARISON OF THE FLORAS ON SUBARCTIC MOUNTAINS IN LABRADOR AND IN FINNISH LAPLAND

BY

ILMARI HUSTICH

HELSINKI — HELSINGFORS
1962

CONTENTS

PRINTED BY TILGMANN
HELSINKI 1962

INTRODUCTION

Recently I received a manuscript written by Mr. LESLIE A. VIERECK (1957) concerning the flora of *Gerin Mountain* in central Labrador. As long ago as 1937, I had been struck by the similarities of the vegetation of the alpine heaths on mountains in Labrador and in Lapland. Looking through Mr. Viereck's list of plants and comparing it with my own floristic study of 1937—40 from the Pallas—Ounastunturi mountain range in western Finnish Lapland, this impression came back to me even more forcefully than before. I therefore ventured to make a closer comparison of the list of species from the two areas (more than 3000 miles apart) without going into taxonomic subtleties and without attempting to draw any far-reaching conclusions as to the reasons for this similarity — my taxonomic knowledge is not sufficient for a deeper comparison.[1]) But the problem itself is in need of study from a slightly unconventional viewpoint. I am grateful to Mr. Wiereck for his courtesy in placing at my disposal his valuable manuscript.

October 1962

I. H.

Map 1. The situation of the mountains described.

[1] For some very helpful suggestions I wish to express my gratitude to Prof. JAAKKO JALAS, Helsinki University.

GENERAL REMARKS ON THE GEOGRAPHY OF THE AREAS

Gerin Mountain, near the border between the Province of Quebec and Newfoundland-Labrador, reaches 940 meters above sea level. It is about 25 miles northwest of the well-known mining town of Schepperville (Knob Lake), where the McGill University Geographical Subarctic Laboratory is situated. I visited the area in 1948 (see H 1951; the expressions H 1951, H 1937, etc., refer to my earlier papers) and in passing also saw Gerin Mt. However, I made only a few notes there (see p. 9) and all the data concerning Gerin Mt. mentioned below are thus based on Viereck's MS of 1957. Figs. 2 and 4 from Viereck's study give a general idea of the morphology of Gerin Mt. It rises above a »semitundra» (see H 1951) of open woodland of black spruce, white spruce and, in places, tamarack on dry ground.

The timber-line on Gerin Mt. is about 760 meters above sea level. The tree-line, i.e. the altitude of the highest stunted trees, reaches near the summit. The same is the case on Irony Mountain, a similar mountain between Gerin Mt. and Knob Lake, visited by the author on September 1st, 1948. According to estimations made in 1948, the height of Irony Mt. was approximately 1000 m. Later measurements give the height of Irony Mt. as 920 m., which means that the timber-line on Irony Mt. is also about 760 m. (H 1951, p. 171). There is a very definite subalpine belt of open spruce and shrubs (Viereck's »*Betula* and *Vaccinium*») between 760 and 830 m. above sea level on Gerin Mt. In some places a loose belt of *Alnus crispa* is visible on the mountain slopes in the Knob Lake area. In this area, however, there is no counterpart to the typical subalpine birch zone on the higher mountain massifs in Finnish Lapland.

The slopes of Gerin Mt. are mostly very gentle; a few deeper gullies occur where snow remains for almost the whole summer (see Fig. 4 and Ives 1960). The summit of Gerin Mt. is dolomite, whilst the slopes and valleys are composed mainly of quartzite. Most of the ridges to the west of the summit, however, consist of shist and iron compounds. Here the till has a very characteristic red color (as over most of the Knob Lake area, because of the hematite). Portions of the east slope of Gerin Mt. are underlaid by »varicolored slates with beds of dolomite» (cf. Viereck l.c., p. 10). The NE slopes of Gerin Mt. drop abruptly to about 570 m., which is the general level of the surrounding area.

The climate of the Gerin Mt. and Knob Lake area is subarctic and rather severe. The average dates of the first and last frost of the season at the Knob Lake station are June 17 and September 16, respectively. The temperature

Fig. 2. Dry exposed »ridge» on Gerin Mountain. Large white vasculum to left of center for scale. Photo: *L. A. Viereck* 1955

during the summer is considerably lower on the summit of Gerin Mt. than at the Knob Lake station; the wind velocity is also, of course, greater. The ample data accumulated for Knob Lake thus give only an approximate idea of the Gerin Mt. climate and are therefore not used here as reference. VIERECK (l.c., p. 13) noted no permafrosts in any of his soil profiles from Gerin Mt. Snow patches remain in shaded spots until August (also seen by the author near Irony Mt. in August 1948); one snowfield persisted below the timber-line for several years until it melted in 1955. (More or less the same behavior of the snow patches has been noted in the eastern ravines on the Pallas—Ounastunturi range.)

There are also smaller alpine areas scattered around Knob Lake, with some gullies with late snow and small pools which suddenly, due to permafrost, dry out in the late summer. The flora of these lower summits is used as additional reference material (see below p. 9). The alpine area of Gerin Mt. is about 15 square miles, i.e. about 39 km².

The *Pallas—Ounastunturi mountain range* rises about 400—500 meters above the forests and lakes surrounding it (see Fig. 3). The area, nowadays a national park, is described in greater detail in H 1937 b. The height of the

highest peak of the range is 821 m., and these mountains are thus slightly lower than the Gerin and Irony mountains. But as the Pallas—Ounastunturi summits rise more directly from the surrounding lakes and forests — mean level about 300 m. — their appearance is more impressive, particularly in the southern part of the range, Pallastunturi; the northern part, Ounastunturi, about Lat.68°N., is lower. The alpine area of Ounastunturi is wide, with gentle slopes and it is in fact very similar in appearance and general morphology to Gerin Mt. (see Fig. 2). The highest summit of the Ounastunturi range is 742 m. above sea level and the area of the alpine region is about 36 km², i.e. more or less the same as on Gerin Mt. There are six different summits and three small lakes at or above the timber-line. Ounastunturi consists primarily of quartzite with patches of minerals richer in calcium. For further details regarding the general geography of Ounastunturi, see KALLIOLA 1939 and H 1937 b. The timber-line on Ounastunturi is largely formed by pine

Fig. 3. Ounastunturi, dry exposed heath, looking south. (1937 b).

with a subalpine, and in places lacking, belt of mountain birch (*Betula Tortuosa*). On the east slope of Ounastunturi the timberline reaches about 400 m. and on the west slope up to 500 m.

*

The data concerning the climate of the two mountain areas are not directly comparable. There are some useful data on the climate of the Knob Lake station in the reports of the above mentioned McGill University Subarctic Laboratory. Scattered data for Ounastunturi and Pallastunturi are also available. In this connection, however, such data are of minor importance because they mostly relate to the forest region. The most interesting data in this respect would, of course, be methodically similar microclimatic measurements on the alpine areas proper. The minor permafrost patterns are more or less the same in the two areas, however, and this suggests that the climate in the alpine region of Gerin Mt. is rather similar to the climate in the corresponding region of Ounastunturi. It is of interest (although I can not assess what influence this fact may have on the composition of the flora, see p. 21 below) that Gerin Mt. is situated at about Lat. 55°N. but Ounastunturi at about Lat. 68°N. The »light climate» is thus different; Ounastunturi lies about 1000 miles further north, with a definitely longer photoperiod, more »arctic» than »alpine».

LIST OF VASCULAR PLANTS ON GERIN MT. AND ON OUNASTUNTURI

Regarding the intensity of floristic work the mountains in Finnish Lapland have naturally been more intensively studied than the until recently completely unknown mountains in central Labrador (compare, for instance, the quantity of literature references in H 1937, H 1940 and Kalliola 1939 with the corresponding references in Viereck 1957 and H 1951). Therefore the floras of Ounastunturi and Gerin Mt., if the latter is drawn entirely from Viereck's study of 1957, are not truly comparable. To neutralize the effect of this different intensity of floristic research in the two areas I have also included in table I below (in brackets only) species found by me in 1948 in the surroundings of Gerin Mt., i.e. on the alpine and »subalpine» region of Irony Mt. and on the lower mountains near Knob Lake.

*

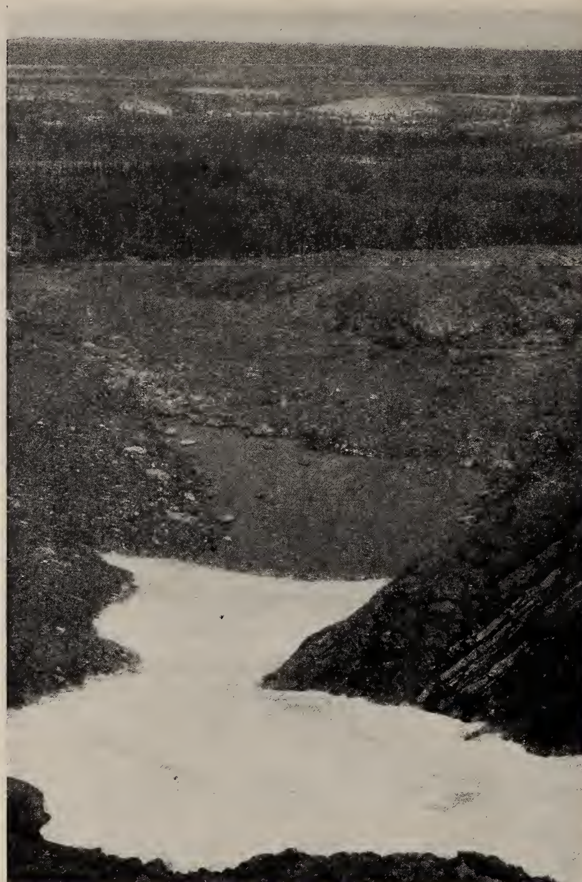


Fig. 4. Semipermanent snow field, gravel meadow and lower part of talus slope above the snow field. Photo: *L. A. Viereck* 1955.

In 1937, I already mentioned that the »low mountains (on the Labrador coast) have a flora very similar to the flora of the Lapland mountains: *Arctostaphylos alpina, Loiseleuria procumbens, Diapensia lapponica, Juncus trifidus, Luzula spicata,* etc. and several cryptogams.» (H 1937 b, p. 191; note also H 1940, p. 62). Later (in Hustich & Pettersson 1945, p. 35) I pointed out that »especially the dry-land vegetation on the mountains on the coast may be considered as almost identical with that of Fennoscandia. One can there find Loiseleuria-Arctostaphylos-Empetrum moors with the same combination of species as on the Labrador coast». In the same paper some examples of this

similarity were given from the low mountains at Cartwright, Rigolet, Pottles Bay and other places nearby on the Labrador coast. The same point was also stressed in H 1951 (p. 199—200) in a comment to the list of plants collected on Irony Mt. (near Gerin Mt.).

The problems of the circumpolar and amphi-atlantic species have been much discussed. Recently the area of the amphi-atlantic species have been mapped by Hultén 1958. Table I illustrates the often (but for very large areas only) stressed similarity between areas in Arctic and Subarctic North America on the one hand, in Eurasia, on the other, revealed by detailed study, in the case of two small areas far distant from each other.

Table I lists from Gerin Mt. *a*) all the species reported by Viereck (1957; marked with a cross) and *b*) some additional species (cross in brackets) which have been observed on Ounastunturi and noted by the author on Irony Mt. (about 15 miles southeast of Gerin Mt.) or on alpine and subalpine habitats near Knob Lake (see above; the species are all mentioned in H 1951).[1] Some of the author's specimens were found on a mountain area which according to information available in 1948 I called »Goodwood Mts.» in my notebook; this name may include Gerin Mt.

The Ounastunturi species in Table I are *a*) all species included in the author's list of H 1940 and *b*) a few species (cross in brackets) which have been found on Gerin Mt. but not on Ounastunturi proper; however, these species have been found nearby in similar alpine surroundings in the Pallastunturi part of the same range.

Thus, the greater intensity of floristic work on Ounastunturi is here to a certain degree »compensated» by the inclusion of species which will almost certainly be found on Gerin Mt. proper. A few silvine species (*Milium effusum, Carex loliacea, Stellaria crassifolia, Veronica serpyllifolia*) which were noted a few times only right at the timber-line on Ounastunturi, have been omitted from the Ounastunturi list; one species (*Viburnum edule*) has been omitted from Viereck's list for the same reason.

---

[1] My collection of 1948 was checked or determined by Dr. A. E. Porsild, Ottawa; for this and much help during my Canadian excursions I here express my gratitude.

Table I.

Species of vascular plants on Gerin Mt. and Ounastunturi Mt. and in their surroundings (see below p. 16).

	Gerin Mt.	Ounas-tunturi Mt.
Equisetum arvense L.	+	+
E. pratense Ehrh.	—	+
E. silvaticum L.	+	+
E. palustre L. s.lat.	(+)	+
E. fluviatile L. (E. limosum L.)	(+)	+
E. scirpoides Michx.	—	+
E. variegatum Schleich.	+	—
Lycopodium selago L.	+	+
L. annotinum L. coll.	+	+
L. clavatum L.	(+)	+
L. alpinum L.	+	+
L. complanatum L.	(+)	+
Selaginella selaginoides (L.) Link.	+	+
Isoëtes lacustris L.	—	+
I. Braunii Dur. (I. echinospora Dur. v. Braunii)	(+)	—
Botrychium lunaria (L.) Sw.	+	(+)
Allosorus crispus (L.) Bernh.	—	+
Cystopteris fragilis (L.) Bernh.	+	(+)
C. montana (Lam.) Bernh.	+	(+)
Dryopteris linnaeana C. Chr.	(+)	+
D. phegopteris (L.) C. Chr.	+	+
D. dilata (Hoffm.) A. Gray[1]	(+)	+
Athyrium alpestre (Hoppe) Milde	—	+
Juniperus communis L.	(+)	+
Sparganium hyperboreum Laest.	(+)	+
Anthoxanthum odoratum L.	—	+
Festuca brachyphylla Schultes	+	—
F. ovina L.	—	+
Poa alpigena (Fr.)	(+)	+
P. alpina L.	+	+
P. glauca M. Vahl	+	—
P. arctica R.Br.	+	—
Agropyron violaceum (Hornem.) Lange	+	(—)[2]
Trisetum spicatum (L.) Richt.	+	—

[1] Cf. HULTÉN (1958, p. 174) and HIITONEN (1950, p. 74) regarding the complex *Dryopteris dilatata* — *D. spinulosa*. The author's specimens from Ounastunturi were determined (in 1936) *D. austriaca* (Jacq.) Woynar. MONTELL (1962, p. 72) reports *D. dilatata* f. *pseudospinulosa* Rosend. from Pallastunturi. From mountain slopes near Knob Lake I collected *D. spinulosa* (O. F. Mull.) Watt. v. *americana* (Fisch.) Fern.

[2] Cf. HULTÉN 1950, p. 68, map of *Agropyron latiglume*.

	Gerin Mt.	Ounas-tunturi Mt.
Nardus stricta L.	—	+
Deschampsia caespitosa (L.) Beauv.[1]	+	(+)
D. flexuosa Trin.	(+)	+
D. atropurpurea (Wg) Scheele	(+)	+
Calamagrostis canadensis (Michx.) Beauv.	+	—
C. purpurea Trin.	—	+
C. neglecta Fl.d.Wett.	—	+
C. lapponica Hartm.	(+)	+
Agrostis borealis Hartm.	(+)	+
Phleum alpinum L.	+	+
Eriophorum spissum Fern.	+	—
E. vaginatum L.	—	+
E. russeolum Fr.	(+)	+
E. angustifolium Honck. (E. polystachyum L.)	+	+
E. Scheuchzeri Hoppe	—	+
Carex gynocrates Wormsk.	+	—
C. dioeca L.	—	+
C. Lachenalii Schk.	+	+
C. canescens L.	(+)	+
C. brunnescens Poir.	(+)	+
C. echinata Murr.	+	—
C. scirpoidea Michx.	+	—
C. norvegica Retz. s. lat.[2]	+	+
C. aquatilis Wg.	+	+
C. Bigelowi Torr (C. rigida Good.)	+	+
C. media R. Br. (C. angarae Steud.)	+	(+)[3]
C. atrata L.	—	+
C. atratiformis Britt.	+	—
C. polygama Schk.	—	+
C. paupercula Michx. (C. magellanica Lam.)[4]	+	+
C. rariflora (Wg.) J. E. Smith	+	—
C. capillaris L.	+	+
C. glacialis Mack. (C. terrae-novae Fern.)	+	—
C. vaginata Tausch.	+	+
C. pauciflora Lightf.	(+)	+
C. chordorrhiza Ehrh.	—	+
C. inflata Huds.	—	+
C. rostrata Stokes	(+)	—

[1] At Gerin Mt. also *D. caespitosa* v. *glauca* (Hartm.) Lindm. as at Knob Lake (H 1951, p. 204).
[2] Re. *Carex norvegica* Retz., see KALELA 1944, p. 116.
[3] Cf. HULTÉN (1950, p. 99) and KALELA (1944, p. 49). MONTELL (1962, p. 26). reports *C. media* from Pallastunturi, reg. subsilvatica.
[4] Cf. HIITONEN 1950, p. 78.

	Gerin Mt.	Ounas-tunturi Mt.
C. limosa L.	(+)	+
C. rotundata Wg.	—	+
C. miliaris Michx.	+	—
Scirpus cespitosus L. s. lat.	+	+
Juncus trifidus L.	+	+
J. filiformis L.	(+)	+
J. albescens (Lange) Fern. (J. triglumis L.)[1]	+	(+)
J. castaneus J. E. Smith	+	—
J. biglumis L.	—	+
Luzula parviflora (Ehrh.) Desv.	+	+
L. spicata (L.) DC.	+	+
L. multiflora (Retz.) L.[2] (incl. L. frigida Sam.)	+	+
L. arcuata Wg. (incl. L. confusa Lindeb.)	+	+
Tofieldia pusilla (Michx) Pers. (T. palustris Huds.)	+	+
Orchis maculatus L.	—	+
Habenaria dilatata (Pursh.) Gray	+	—
Coeloglossum viride Hartm.	—	+
Listera cordata (L.) R.Br.	(+)	+
Salix vestita Pursh.[3]	+	—
S. herbacea L.	+	+
S. polaris Wg.	—	+
S. Uva-ursi Pursh.	+	—
S. arctophila Cock.	+	—
S. cordifolia Pursh. v. intonsa Fern.	+	—
S. glauca L.s. lat.	+	+
S. argyrocarpa Anders.	+	—
S. myrtillifolia Anders.	+	—
S. myrsinites L.	—[4]	+
S. lapponum L.	—	+
S. livida Wg.	—	+
S. caprea L.	—	+
S. phylicifolia Sm.	—	+
S. planifolia Pursh.	+	—
S. nigricans Enand.	—	+
S. hastata L.	—	+
Betula glandulosa Michx.	+	—
B. nana L.	—	+
Oxyria digyna (L.) Hill.	+	+

[1] Acc. to map in HULTÉN 1950 the species is found on Ounastunturi or at least very near it.

[2] *L. multiflora* (Retz) Lej. v. *frigida* (Buch) Sam. found on »tundra plateau near Goodwood» (H 1951, p. 207), which locality is probably identical with Gerin Mt., see p. 9 above.

[3] Re. numerous *Salix*-hybrids found on Pallastunturi, see MONTELL 1962.

[4] Cf. p. 19 below.

	Gerin Mt.	Ounas-tunturi Mt.
Rumex arifolius All.	—	+
Polygonum viviparum L.	+	+
Sagina Linnaei Presl.	+	+
Arenaria macrophylla Hook.	+	—
A. humifusa Wg.	+	—
A. groenlandica (Retz.) Spreng.	+	—
A. sajanensis Willd. (Alsine biflora (L.) Sw.)	+	+
Stellaria longipes Goldie. coll.	+	—
S. calycantha Bong.	(+)	+
Cerastium alpinum L.s.lat.	+	+
C. caespitosum L. ssp. alpestre Hartm.	—	+
C. arvense L.	+	—
C. lapponicum Cr.	—	+
Viscaria alpina G. Don.[1]	(+)	+
Ranunculus reptans L.	(+)	+
R. pygmaeus Wg.	—	+
R. nivalis L.	—	+
R. Allenii Robins.	+	—
R. acris L.[2]	—	+
Thalictrum alpinum L.	—	+
Anemone parviflora Michx.	+	—
Caltha palustris L.	—	+
Trollius europaeus L.	—	+
Draba norvegica Gunn. (D. rupestris R.Br.)	+	(+)
Cardamine bellidifolia L.	+	+
C. pratensis L.	(+)	+
Arabis alpina L.	+	+
Saxifraga stellaris L.	—	+
S. nivalis L.	—	+
S. Aizoon Jacq.	+	—
Sibbaldia procumbens L.	+	+
Potentilla palustris L. (Comarum palustre L.)	(+)	+
P. Crantzii Gr.	—	+
Dryas integrifolia M. Vahl.	+	—
D. octopetala L.	—	+
Geum rivale L.	+	(+)
Rubus chamaemorus L.	+	+
R. saxatilis L.	—	+
R. pubescens Raf.	(+)	—
R. acaulis Michx.	+	—
R. arcticus L.	—	(+)

[1] Cf. Löve 1954, p. 216 re. *Viscaria alpina* v. *americana* Fern., an »intraspecific vicarious race» in North America.
[2] Cf. Montell 1962, p. 120.

	Gerin Mt.	Ounas-tunturi Mt.
Alchemilla glomerulans Bus.	—	+
A. filicaulis Bus.	(+)	—
Astragalus alpinus L.	+	+
Geranium silvaticum L.	—	+
Empetrum hermaphroditum (Lge.) Hagerup[1]	+	+
Viola labradorica Schrank.	+	—
V. palustris L.	—	+
V. epipsila Led.	—	+
Epilobium angustifolium L.	+	+
E. latifolium L.	+	—
E. palustre L.	(+)	+
E. davuricum Fisch.	—	+
E. lactiflorum Hausskn.	—	+
E. Hornemanni Reichenb.	+	+
E. alsinifolium Vill.	—	+
E. anagallidifolium Lam.	+	+
Angelica archangelica L.	—	+
Cornus canadensis L.v. intermedia Farr.	+	—
C. suecica L.	—	+
Pyrola minor L.	+	+
P. secunda L.	(+)	+
P. rotundifolia L.[2]	—	+
P. grandiflora Rad.	+	—
Ledum groenlandicum Oed.	+	—
L. palustre L.	—	+
Rhododendron lapponicum (L.) Wg.	+	—
Loiseleuria procumbens (L.) Desv.	+	+
Kalmia polifolia Wang.	+	—
Phyllodoce coerulea (L.) Bab.	+	+
Andromedia polifolia L.	—	+
A. glaucophylla Link.	(+)	—
Cassiope hypnoides (L.) Don.	+	+
Arctostaphylos alpina (L.) Spreng.	+	+
Vaccinium uliginosum L. s.l. (incl. v. alpinum Bigel)	+	+
V. myrtillus L.	—	+
V. Vitis-idaea L.[3]	+	+
Oxycoccus microcarpus Turcz.	(+)	+
Calluna vulgaris Hill.	—	+

[1] Cf. discussion in Löve 1962.

[2] Cf. Hultén 1949, p. 392 and Löve 1954, p. 218 re. *Pyrola norvegica* Knaben and *P. americana* Sweet.

[3] *Vaccinium Vitis-idaea* v. *minus* Raf. and *Menyanthes trifoliata* v. *minor* Raf. are intraspecific vicarious races acc. to Löve, l.c., cf. also Hultén, l.c., p. 317.

	Gerin Mt.	Ounas-tunturi Mt.
Diapensia lapponica L.	+	+
Menyanthes trifoliata L.	(+)	+
Trientalis europaea L.	—	+
T. borealis Raf.	(+)	—
Veronica alpina L. s. lat.	+	+
V. humifusa Dick.	—	+
Castilleja septentrionalis Lindb.	+	—
Euphrasia latifolia Pursh.	—	+
Bartsia alpina L.	+	+
Pedicularis flammea L.	+	—
P. lapponica L.	—	+
P. labradorica Wirsing	+	—
P. groenlandica Retz.	+	—
Pinguicula villosa L.	—	+
P. vulgaris L.	(+)	+
Linnaea borealis L.[1]	+	+
Solidago multiradiata Ait.	+	—
S. virgaurea L.	—	+
S. macrophylla Pursh.	+	—
Antennaria angustata Greene	+	—
A. alpina R. Br.	—	+
A. dioeca Gaertn.	—	+
Gnaphalium supinum L.	+	+
G. norvegicum Gunn.	+	+
Achillea borealis Bong.[2]	+	(+)
Petasites palmatus (Ait.) Gray	+	—
P. frigidus Fr.	—	+
Saussurea alpina (L.) DC.	—	+
Arnica alpina L. ssp. angustifolia (J.Vahl) Maquire	+	—
Senecio pauciflorus Pursh.	+	—
Cirsium heterophyllum Hill.	—	+
Taraxacum lapponicum Kihlm. (T. croceum Dahlst.)	+	+
Hieracium alpinum L.	—	+
H. nigrescentia coll.	—	+

[1] At Gerin Mt. *L. borealis* ssp. *americana* (Forbes) Hult., which acc. to Löve, l.c. is an intraspecific vicarious race.

[2] *Achillea borealis* Bong. is identical with *A. millefolium L.* v. *nigrescens* E. Mey or A. *nigrescens* (E. Mey) Rydb. »common in alpine meadows» (H 1951, p. 215); a very similar variety is found on mountains S of Ounastunturi (H 1940, p. 60).

COMPARISON OF THE FLORAS

Table I comprises 151 species from Gerin Mt. (120 of which appear in VIERECK's list of 1957) and 166 species found by the author on Ounastunturi (see p. 9 above).

A. 54 species grow both on Gerin Mt. and on Ounastunturi Mt. It should be stressed that it is *among these species that are common to both areas that we have some of the commonest and most prominent vegetation-forming species of the alpine vegetation of the two areas.*

B. Quite a few of the Ounastunturi species, 30, have not been found on Gerin Mt. proper but on Irony Mt., on Goodwood Mts. (see p. 9) or on mountains near Knob Lake, acc. to H 1951. Most of them will certainly be found — after an intensified search — on Gerin Mt. as well; they are marked (+) in the list.

C. Of the species growing on Gerin Mt., 10 species have not been found on Ounastunturi proper, but only, so far, in the surroundings, although on similar alpine or subalpine habitats. They are marked (+) in the list.

Thus, 94 of the 151 species, i.e. 62 %, growing on Gerin Mt., incl. (+)-species, see above, are the same as the species growing on Ounastunturi, about 3000 miles apart, see map 1. This »circumpolarity» of the flora is, thus, certainly a highly significant feature not only in the Arctic region proper, but also on the isolated »low-alpine islands» in the northernmost part of the boreal conifer region. — The similarity is still greater, however, than this 62 % suggests.

D. Several species in Table I are so closely related that they were still rather recently included in the same species as different varieties only. Partly following LÖVE (1954), I have below divided the pairs into *vicarious, substitution* and *corresponding* taxa.

Gerin Mt.		Ounastunturi Mt.
Vicarious species:		
Eriophorum spissum	—	E. vaginatum
Carex atratiformis	—	C. atrata
Dryas integrifolia	—	D. octopetala
Rubus acaulis	—	R. arcticus
Pyrola grandiflora	—	P. rotundifolia ?
Andromeda glaucophylla	—	A. polifolia

Substitution species:

Carex gynocrates	—	C. dioeca
Salix cordifolia	—	S. glauca
S. planifolia[1]	—	S. phylicifolia
Rubus pubescens	—	R. saxatilis
Cornus canadensis	—	C. suecica
Ledum groenlandicum	—	L. palustre

Corresponding taxa:

Carex miliaris	—	C. rotundata
C. rostrata	—	C. inflata
Trientalis borealis	—	T. europaea[2]
Solidago macrophylla	—	S. virgaurea[2]

E. Some species are closely related to each other (and physiognomically and ecologically play exactly the same role in the vegetation):

Equisetum variegatum	—	E. scirpoides
Isoëtes Braunii	—	I. lacustris
Festuca brachyphylla	—	F. ovina
Betula glandulosa	—	B. nana
Alchemilla glomerulans	—	A. filicaulis
Antennaria angustata	—	A. alpina
Solidago multiradiata	—	S. virgaurea

If we include these 23 D and E-species (the species from Gerin Mt. to the left in the lists above) it means that 77 % of the species of Gerin Mt. also grow on Ounastunturi or have here closely vicarious, substitution or corresponding taxa.

F. According to Table I the following species, which grow on Gerin Mt. (with the exceptions just mentioned above of species closely related to each other) do not occur on Ounastunturi proper, but are found in other parts of northern Europe: *Poa arctica* (rare), *P. glauca* (r.), *Trisetum spicatum* (r.), *Agropyron violaceum* (common in the subalpine region), *Carex echinata* (r.), *C. scirpoidea* (scattered), *C. rariflora* (com.), *C. glacialis* (r.), *Juncus castaneus* (scat.), *Arenaria humifusa* (scat.), *Stellaria longipes* (com.?), *Cerastium arvense* (r., subalp.), *Saxifraga Aizoon* (occasional; in south Norway only, Hultén 1950), *Rhododendron lapponicum* (r.), *Castilleja septentrionalis* (C

[1] Acc. to Hiitonen (1950, p. 82) *S. phylicifolia* ssp. *planifolia* (Pursh.) Hiit
[2] Cf. Hiitonen l.c., p. 76—77.

pallida; occasional on Kola peninsula, HULTÉN l.c.), *Pedicularis flammea* (r., subalp.), *Arnica alpina* (r.), i.e. 17 species.

G. Of the remaining 17 species in the Gerin list the following have close »relatives» in the alpine and subalpine habitats of Ounastunturi: *Ranunculus Allenii* (*R. nivalis*), *Pedicularis labradorica* (*P. lapponica,* see below p. 18), *Solidago multiradiata* and *S. macrophylla* (*S. virgaurea*) and *Petasites palmatus* (*P. frigidus*).

H. If we look at the remaining Gerin species in Table I of which nothing so far has been said concerning their taxonomic relations to the Ounastunturi species, we note that 5 of them are Salices. Of these, only *Salix Uva-ursi* is strikingly common in Labrador. *S. Uva-ursi* belongs to the same section of Salices as *S. herbacea,* but occurs in dry habitats. *Salix vestita* (though bigger) is rather closely similar to *S. reticulata,* which is found in northern Europe, not far from Ounastunturi. Most of the above-mentioned species are of minor importance in the flora and vegetation.

Of the Gerin plants not found on Ounastunturi, *Kalmia polifolia* (common on bogs in Labrador) is an example of a genus not found in northern Europe. *Senecio pauciflorus, Epilobium latifolium, Arenaria macrophylla* and *Pedicularis* (*Elephantella*) *groenlandica* represent — within their genera — rather unusual elements from our point of view.

I. The following species which grow on Ounastunturi do not occur on Gerin Mt. or in the Knob Lake area, but have been found in eastern Labrador, particularly in the coastal area:

Equisetum pratense (occ.), *Athyrium alpestre* (occ.), *Eriophorum Scheuchzeri* (occ.), *Carex polygama* (r.), *C. chordorrhiza* (occ.), *Juncus biglumis* (r.), *Cerastium caespitosum* (r.), *C. lapponicum* (r.), *Ranunculus pygmaeus* (r.), *R. nivalis* (r.), *R. acris* (occ.), *Thalictrum alpinum* (r.), *Caltha palustris* (occ.), *Saxifraga stellaris* (r.), *S. nivalis* s.l. (r?), *Potentilla Crantzii* (occ.), *Viola palustris* (occ.), *Epilobium lactiflorum* (r.), *Euphrasia latifolia* (= *E. frigida,* occ.), *Pedicularis lapponica* (occ.), *Pinguicula villosa* (r.).

K. Of the remaining 29 species (which grow on Ounastunturi but not on Gerin Mt. or on the mountains near Knob Lake) the following have rather close »vicariants[1]» in the Knob Lake area:

---

[1] This paper was ready for the printer when I received Dr. ERIC HULTÉN's important book, »The Circumpolar Plants, I» (Kungl Sv. Vet. Akad. Handl. IV,8, 1962). Dr. Hultén's opinions regarding the taxonomy of some species differ considerably from the opinions expressed by some of the authors quoted above. He includes i. a. *Calamagrostis purpurea* as a »major subdivision» in *C. canadensis. Carex inflata* is included in *C. rostrata* and *C. gynocrates* is placed as a subspecies to *C. dioica,* etc. This means that the »similarity percentage» mentioned on p. 16 above rises to about 65 %.

Calamagrostis purpurea (*C. canadensis*), *Salix livida* (*S. Bebbiana* Sarg., which grows at Knob Lake, H 1951; cf. HIITONEN 1950, p. 82), *Vaccinium myrtillus* (*V. angustifolium*, *V. caespitosum*), *Hieracium nigrescentia* (*H. canadense*?). Note also the species listed on p. 18: *Ranunculus nivalis* (*R. Allenii*) and *Petasites frigidus* (*P. palmatus*).

If we look at the remaining 23 species of this group, we find that 7 of them are Salices (see above p. 18). Of these, *S. polaris* is very close to *S. herbacea*. *Salix myrsinites* is so close to the Labrador Salices that one specimen brought home from Knob Lake by me in 1948 was determined as *S. myrsinites* by Dr. I. HIITONEN (still unchecked). The relationship of the other Salices from Ounastunturi (*S. lapponum*, *S. caprea*, *S. livida*, *S. nigricans* and *S. hastata*) to the Gerin Salices is uncertain. It seems that among the Salices particularly there is much taxonomic work to be done before a true picture of their distribution is possible.

Types of species from Ounastunturi which are entirely absent from the eastern Labrador area are *Nardus stricta*, *Geranium silvaticum*, *Calluna vulgaris* and *Saussurea alpina*. *Nardus stricta* is of some importance in the alpine vegetation of Ounastunturi and *Calluna vulgaris* on Pallastunturi.

This inventory leads us to the conclusion that only 3—5 % of all the species on either Gerin Mt. or Ounastunturi are taxonomically entirely alien to the other area. The majority of the species which compose the flora of the two alpine areas 3000 miles apart are identical or very closely related to each other.

SOME COMMENTS ON THE TREE SPECIES OF THE SUBALPINE AND THE SILVINE REGION

Table I contains alpine or subalpine species only. However, the tree species on the mountain slopes are also of great interest in this connection. We note that there is a great similarity between the tree species of the subalpine region, but when we go down to the timber-line proper and down beyond into the forests around the mountains we find great differences.

The tree species which form the partly indistinct subalpine region on Ounastunturi are *Betula tortuosa* Ledeb. and *Sorbus aucuparia* L. (which on Ounastunturi extends as high up the mountain slopes as the mountain birch, cf. H 1940, p. 55). In the Gerin Mt. and Knob Lake alpine areas *Betula tortuosa* has its counterpart in *B. minor* (Tuckerm.) Fern. and *Betula borealis* Michx., which, although not common, both occur on the mountain slopes near Knob Lake. Both, particularly *B. minor*, are related to *Betula tortuosa*: »*Betula minor* closely simulates the Arctic Eurasian and Greenland shrub, there passing

as . . . *B. tortuosa* Ledeb.» (Fernald 1945, p. 307). *Sorbus aucuparia* is near *S. decora* (Sarg.) Hyland, probably nearer than is usually realized; *S. aucuparia* has a glabrous northern variety (v. *glabrata* (W. & G.) Hedl.), which grows all over northern Fennoscandia, compare *S. decora* v. *groenlandica* (Schneid.) Fern.

The alder (*Alnus crispa* (Ait.) Pursh.) sometimes occurs in Labrador on the mountain slopes as an indistinct belt (H 1939); Viereck (l.c., p. 46) writes that *Alnus crispa* occurs »in very sheltered locations in the subalpine zone» on Gerin Mt. In the Knob Lake area the alder is »very common along shores of lakes and rivers, in swampy forest and on subalpine slopes» (H 1951, p. 208). Its nearest relative in northern Europe is *Alnus incana* Moench., growing near and below Ounastunturi but not on the mountain itself (see H 1940, p. 51—52). There are northern varieties and forms of *Alnus incana* (cf. Hultén 1949, p. 389) which are glabrous like *Alnus crispa*. But, according to Fernald (l.c.), the true vicarious species of *Alnus incana* in Labrador is *Alnus rugosa* (DuRoi) Spreng. v. *americana* (Regel) Fern., which does not grow on the mountains at all but in the taiga region (see also H 1951). The alder belt (*Alnus crispa*) above the conifer tree-line on the Labrador coast is similar to the belt of *Alnus incana* on the mountains in Finmark (northernmost Norway).

The timber-line on the mountains was discussed above; we noted that its height is approximately 750—850 m. above sea level in the Gerin Mt. area, whereas it is about 500—560 m. on Ounastunturi. On both mountains the timber-line proper is formed, of course, by conifers. Seen from the distance, the timber-line trees look very similar in both areas owing to the naturally similar effect of the wind, snow and cold on the habitus of the trees (re. the tree species of the circumpolar tree-line, see H 1953).

The tree-line on Gerin Mt. is formed by *Picea glauca* (Moench) Voss, *P. mariana* (Mill.) BSP and *Larix laricina* (DuRoi) Koch. Viereck (l.c., p. 37) notes that »*Picea glauca* is the more common of the two spruce species in the subalpine and in the occasional clumps that are found in the alpine zone. It becomes somewhat *Krummholz* in form but never forms the low mats of *Picea marina;* gnarled trees with a diameter of ten to twelve inches occur in the subalpine». Note also the author's description of the two spruce species in H 1951 p. 174—5; I noted, among other things, that near the timber-line on Irony Mt. stunted white spruce and black spruce often look alike, but usually when the two species grow together, as in the semitundra on Irony Mt., white spruce forms a rugged tree, but black spruce occurs only as a low shrub. Tamarack or larch forms parts of the tree-line on Gerin Mt. and Viereck (l.c., p. 36) reported seedlings of larch at about 860 m. above sea level. Larch is absent from northern Europe (H 1953).

On Ounastunturi the timber-line is mainly formed by *Pinus silvestris* L., with scattered *Picea excelsa* Link. Seedlings of pine reach about 600 m. on Ounastunturi and in recent time they have been more frequent. As Ounastunturi lies very close to the northern limit of the spruce, spruces are not as common there as in the southern part of the mountain range. However, scattered *Picea excelsa* grows up to 560 m. on Ounastunturi also.

As I pointed out in H 1953, it is surprising »that not a single arborescent species is circumpolar, even though several birches of the forest-tundra may be closely related. Not even the dwarf birch, *Betula nana*, is circumpolar, for in some parts of the Subarctic it is replaced by species of similar growth habit and ecology (*B. exilis*) and (*B. glandulosa*). Only *Juniperus communis* (incl. var. *montana*) is almost completely circumpolar» (H 1953, p. 161).

Juniperus communis coll. occurs scattered on Ounastunturi in the alpine region and is more generally found on the southern peaks of the range. Juniper was not noted by VIERECK (l.c.) from Gerin Mt., but according to H 1951 (p. 203) *J. communis* var. *depressa* Pursh. was collected on dolomite cliffs, in open lichen heaths and in the subalpine region of Irony Mt.

The alpine regions on Gerin Mt. and on Ounastunturi are floristically very much alike, but the forest region on the mountain slopes is composed of different tree species. But if we study the ground vegetation of the northern forests, we find astonishing similarities in their ecology and physiognomy. That, however, is a different problem.[1]

DISCUSSION

The temperature, wind, moisture and winter conditions are roughly similar in the areas on and around Gerin Mt. and Ounastunturi. There are similarities in the bedrock geology, but particularly regarding the quaternary history of the two areas, both areas have until a late stage been covered by ice.

The light conditions, however, are not entirely similar and the difference may to some extent influence the taxonomy of closely related species. As map 1 shows, Gerin Mt. lies on about Lat. 55°N., Ounastunturi on about Lat. 68°N., a considerable difference, which means that whereas the summer on Gerin Mt. is as short as in Britain, the »summer light» on Ounastunturi is nearly 50 days. This difference in the length of the light season might perhaps explain

[1] In passing, it should be noted that the first anthropochorous species noted by VIERECK (l.c.) around Gerin Mt. was *Rumex acetosella* L.; this species was also among the first anthropochores noted on Ounastunturi.

some minor differences in leaf form, etc. In this respect attention should be drawn to a recent study by MOONEY and BILLINGS (1961) on the comparative physiologic ecology of different populations of *Oxyria digyna* (which occurs on both Gerin Mt. and Ounastunturi). The authors note in detail the differences between arctic and alpine populations of *Oxyria digyna*, regarding number of stamens, inflorescence branches, presence or absence of rhizomes, etc. They also noted a »north to south cline of increased flower production and of decreasing rhizome production» (l.c., p. 28); compare also BLISS (1962, p. 123). Such investigations are needed for other wide-ranging circumpolar species as well. If I am permitted a slightly impertinent comment: it seems that the taxonomists allow a certain plant species greater morphological amplitude if it grows in different habitats within the same region than when the same species grows in two areas thousands of miles from each other.[1]

Table I and the other data above indicate clearly that the circumpolarity, which marks the arctic flora, continues southwards to the outposts of the Arctic formed by the isolated mountain massifs in the northernmost part of the Boreal Forest Region. It is also clear that the similarity as we descend the mountain slopes decreases rapidly because the variety of habitats increases (owing to changing temperature, moisture and light conditions, etc., on the lower slopes compared to the light-exposed alpine plateaus). And in the forest region proper we note that the dominant tree species are different.

Above, the historical aspect has not been dealt with. HULTÉN has (1950) divided the flora of Northern Europe into 48 phytogeographic groups on the basis of their distribution at the present time. The species in Table I which grow in northern Europe belong, according to HULTÉN's classification, to 27 different groups. The majority are »arctic-boreal circumpolar», »boreal-montane» or »amphiatlantic arctic-montane» species. However, even if such a grouping is of minor interest in this connection, it shows the diversity of the origin of the flora in such small areas as are discussed here.

Of a certain interest is the decrease in the *quantity* of arctic-alpine species as we move from north to south along a broken series of mountains rising above the forest. I made such a study (1940) along the low mountain range in western Finnish Lapland, thus including Ounastunturi. 41 alpine and so called alpike species grow on Ounastunturi (alpike species are alpine species which in the area in question also grow in the silvine region), but only 5—8 species on the

---

[1] After a period of dividing former species, which is still going on as floristic and taxonomic research increases (compare HULTÉN 1958), we have reached a period when we have to decide where to stop. When are populations of a species truly comparable with each other?

smallest and southernmost mountains in the mountain range (see H 1940, p. 9). The alpine species which grow on the most isolated mountains in the forest region are *Lycopodium alpinum*, *Carex Bigelowii* (= *C. rigida*), *Juncus trifidus*, *Loiseleuria procumbens*, *Phyllodoce coerulea*, *Arctostaphylos alpina* and *Hieracium alpinum*, all very common alpine plants in Northern Europe (cf. WISTRAND 1962). It is interesting to note that these species belong to different types regarding the distribution of their diaspores.

There is a correlation between the width of the alpine areas in question and the number of species. In general, we can state that the fading out of the arctic-alpine element towards the continuous forests means that the commonest »circumpolar elements» persist as long as there is a small area exposed to arctic-alpine climatic conditions. The same was noted from the isolated mountains on the Labrador coast and on the small mountains rising above the timberline in the vicinity of the Irony Mt. and Gerin Mt. in central Labrador. This partly explains the physiognomic, ecologic and taxonomic similarities of the flora on the low isolated mountains of Labrador and the isolated »fjelds» of Northern Europe, areas that are separated by a distance of 3000 miles.

REFERENCES

BLISS, L. C. 1962. Adaptions of Arctic and Alpine Plants to Environmental Conditions. Arctic. Vol. 15, 2. Montreal.

FERNALD, M. L. 1945. Some North American Corylacae (Betulacae). Rhodora, Vol. 47. Boston.

—»— 1950. Gray's Manual of Botany. Eighth Ed. New York.

HIITONEN, I. 1950. Über die gemeinsamen Züge der Floren von Nordamerika und Fennoskandien. Mem. Soc. Fauna Fl. Fenn. 25. Helsingforsiae.

HULTÉN, E. 1949. On the Races in the Scandinavian Flora. Sv. Bot. Tidskr. 43. Uppsala.

—»— 1950. Atlas över växternas utbredning i Norden. Stockholm.

—»— 1958. The Amphi-Atlantic Plants and their Phytogeographical Connections. Kungl. Vet. Akad. Handl. IV, 7. Stockholm.

HUSTICH, I. 1937a. Newfoundland-Labrador. Terra. Helsinki.

—»— 1937b. Pflanzengeographische Studien im Gebiet der niederen Fjelde im westlichen finnischen Lappland I. Acta Bot. Fenn. 19. Helsingforsiae.

—»— 1940. Idem II. Ibid. 27.

—»— 1951. Forest-Botanical Notes from Knob Lake Area in the Interior of Labrador Peninsula. Nat. Mus. of Canada Bull. 123. Ottawa.

—»— 1953. The Boreal Limits of Conifers. Arctic. Vol. 6, 2. Montreal.

HUSTICH, I. and PETTERSSON, B. 1944. Notes on Vascular Plants of the East Coast of Newfoundland-Labrador. I. Mem. Soc. Fauna Fl. Fenn. 19. Helsingforsiae.

—»— 1945. Idem II. Ibid. 20.

IVES, J. D. 1960. Semipermanent snow beds in Central Labrador-Ungava. McGill Subarct. Res. Papers 9. Montreal.

KALELA, A. 1944. Systematische und Pflanzengeographische Studien an der Carex-Subsection Alpinae Kalela. Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo 19, 3. Helsinki.

KALLIOLA, R. 1939. Pflanzensoziologische Untersuchungen in der alpinen Stufe Finnisch-Lapplands. Ibid. 13, 2.

LÖVE, A. 1954. Cytotaxonomical Evaluation of Corresponding Taxa. Vegetatio V—VI. Haag.

LÖVE, D. 1960. The red-fruited crowberries in North America. Rhodora, Vol. 62. Boston.

MONTELL, J. 1962. Vegetationen och floran i Muonio socken. Mem. Soc. Fauna Fl. Fenn. 37. Helsingforsiae.

MOONEY, H. A. and BILLINGS, W. D. 1961. Comparative physiological ecology of arctic and alpine populations of Oxyria digyna. Ecol. Monogr. 31. New York.

RAYMOND, M. 1957. Le Carex rotundata en Amérique du Nord. Naturaliste Canad. 84. Montreal.

VIERECK, L. A. 1957. The Flora of Gerin Mountain, Central Quebec-Labrador. Copy of M. Sc. thesis. Univ. of Colorado, Boulder.

WISTRAND, G. 1962. Studier i Pite Lappmarks kärlväxtflora. Acta Phytogeogr. Suecica 45. Uppsala.

ACTA GEOGRAPHICA 17: 3

A PRELIMINARY INVENTORY OF THE VASCULAR PLANTS IN THE EASTERN PART OF CENTRAL LABRADOR PENINSULA

BY

ILMARI HUSTICH

HELSINKI—HELSINGFORS
1963

CONTENTS:

PRINTED BY TILGMANN
HELSINKI 1963

INTRODUCTION

Newfoundland-Labrador was visited in 1937 by a Finnish expedition. The leader was Dr. *Väinö Tanner*, geologist and geographer, and the other members Dr. *E. H. Kranck* as geologist, and the author as a young botanist and ecologist. The result of the expedition were presented in several papers. Particularly Tanner's work »Outlines of the Geography, Life and Customs of Newfoundland-Labrador» (1944) contains an immense amount of information regarding the area, including its flora and vegetation. In 1939 the author wrote a paper on the forest and tree limits along the coast. Together with Dr. *Bror Pettersson* SON I published a preliminary list of the vascular plants collected during the expedition (HUSTICH & PETTERSSON 1944—45). In 1939 Dr. *Tanner* returned to the coast accompanied by the palynologist Dr. *C. G. Wenner;* Wenner's paper (1949) is of great interest also from a purely phytogeographical point of view.

After the war I returned to eastern Canada, mainly in order to make forest-botanical studies on the Labrador Peninsula and around Hudson Bay (1946—48, 1952, 1956). During these trips, however, the area dealt with in this paper was visited only in 1948 and 1952.

Since the war, the Ungava-Labrador Peninsula has been the object of relatively intensive geographical studies, particularly in the Knob Lake area. Several papers have already been published regarding such features as forest and cover types (see HARE 1959), but regarding the flora and vegetation our knowledge is still very superficial.

Every phytogeographical analysis must be based on the flora and its structure. I, therefore, begin this study with a simple inventory of the flora, using my own notes and collections and information from various sources; the Labrador collections in the American and Canadian Botanical Museums are more or less beyond my reach. Chapter I thus contains only a preliminary list of vascular plants found in the area, pending a more thorough analysis by a Canadian taxonomist specialized in the boreal and subarctic flora. Phytogeographical problems and the forest-botany of the area chosen here (see map 3) are discussed in a later paper. As general data on the area are readily available in many papers (including those already mentioned) such data are omitted here; if necessary they will be cited in connection with a discussion of the phytogeographical problems.

In this connection I would like to thank Dr. *A. E. Porsild*, Dr. *A. L. Washburn* and Dr. *F. K. Hare* for their generous help in many connections, and also Mr. *George Jacobsen*, Dr. *J. J. Rousseau* and many others, see p. 10 below. To the *Arctic Institute of North America*, *National Museum of Canada* and the *Botanical Garden* in Montreal I owe a particularly great debt of gratitude for their generous assistance. It is my hope that this paper will stimulate the interest in this large boreal and subarctic area, today still among the largest virgin areas in the world.

Many of the kind people who went out of their way to help the Finland-Labrador Expedition of 1937 (see TANNER 1944) are now dead.

I. THE FLORISTIC MATERIAL

The purpose of this list of vascular plants is to give a concise (but still *preliminary*) inventory of the flora of the Boreal and Subarctic part of Newfoundland-Labrador, from Battle Harbour in the south to Hebron in the north (see map 1—2), thus providing a background for phytogeographical discussions. At the same time we have here in one list all the material collected by the two expeditions from Finland to Labrador in 1937 and 1939 and by myself in 1948 and 1952. Other available information on the flora has, of course, also been used (see below). The accumulated data are condensed as much as possible, numbers and abbreviations being used instead of the names of localities and collectors.

Collections and collectors:

a. The localities where I made my collection in 1937 have been described in considerable detail (HUSTICH & PETTERSSON, 1945, p. 30—45). Therefore only the shortest possibly identification is used below:

H1, Battle Harbour. H2, St. Mary River near Lewis Bay. H3, Francis Bight. H4, Wenison Tickle. H5, Squash Run. H6, Boulders Harbour. H7, Sandy Banks on Island of Ponds. H8, Island near Indian Tickle. H9, Long Island. H10, Cartwright. H11, hill southeast of Cartwright. H12, Huntington Island. H13, skerry outside Huntington Island. H14, Duck Island, Sandwich Bay. H15, White Bear River (Dove Brook) in Sandwich Bay. H16, Rigolet. H17, Narrows opposite Rigolet. H18, Moliak Cove. H19, Eskimeau Island, Lake Melville. H20, Northwest River. H21, Double Mer, north shore, innerpart. H22, Double Mer, Pompus Head and Broken Rocks, a small peninsula. H23, small hill opposite Pompus Head, Double Mer. H24, Double Mer Point. H25 north shore east of Double Mer Pt. H26, Black Island, Hamilton Inlet. H27, inner

part of Pottles Bay. H28, north shore of Pottles Bay. H29, Cape St. Giles. H30, Indian Harbour. H31, Smokey Island. H32, Holton Cape. H33, Ragged Islands. H34, Makkovik, near the HBC-station. H35, »Makkovik Mts» on south shore of Makkovik Bay. H36, Peason's Cove, Makkovik Bay. H37, some miles inland from Makkovik station. H38, Wild Bight near Manak. H39, small island outside Wild Bight. H40, Dunns Island. H41, South shore of Cape Aillik. H42, inner part and north shore of Cape Aillik. H43, Windsor's Harbour. H44, Hopedale, near mission station. H45, Mr. White's place south of Nain. H47, Nain, near mission station. H48, »Queens Lake» archipelago. H49, Nutak. H50, Kaumajet Mts. H51, Hebron, near HBC-station.

The expression »H1,3, *16*,18,*20*,21» means that the species in question was collected from the localities *H16* and *H20* (note Italics) and noted, but no

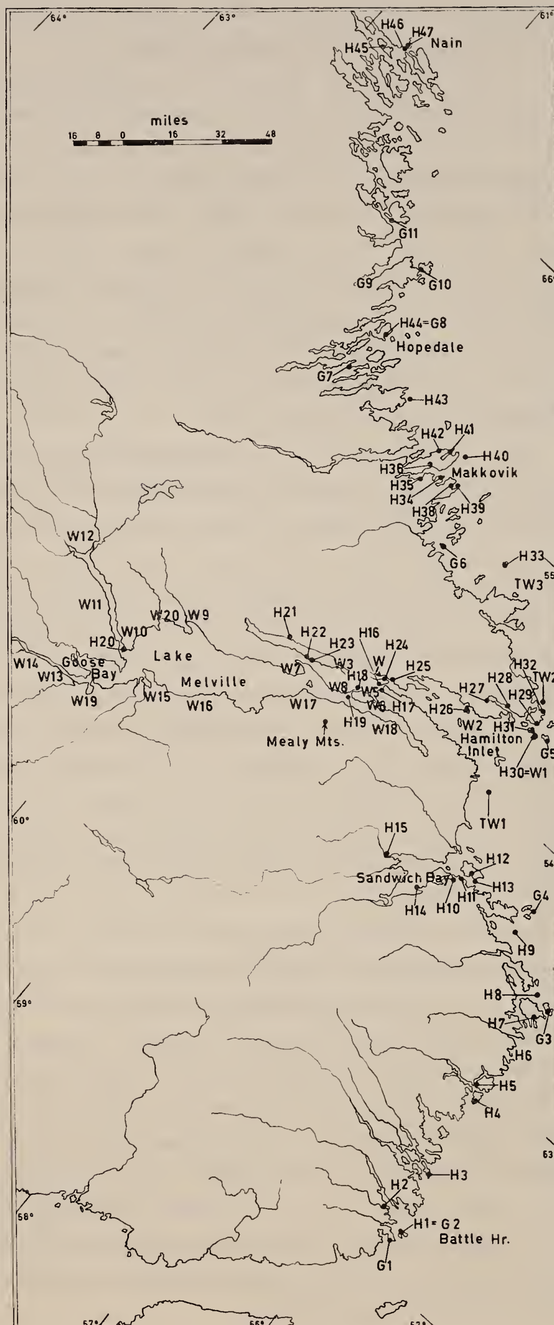


Fig. 1. Localities along the coast of Labrador.

specimen preserved, from the localities H1, H3, H18 and H21, i.e. according to the catalogue of the localities above.

b. Dr. *V. Tanner* and Dr. *C. G. Wenner*'s collection of 1939 is mainly from the following localities (only localities from which specimens were preserved are included here): TW1, Stag Island. TW2, Holton Island, TW3, Ragged Islands. TW4, Sandy Island near Nain. TW5, Whale Island near Nain. TW6, Slambang Bay near Nain. TW7, Lindburg Island, near Nutak. TW8, Port Manvers. TW9, Mugford Tickle, Kaumajet Mts. Dr. V. Tanner also took a few unlabelled pieces of specimens from his inland trip in 1939 near Grand Lake; they are mentioned in the text if they add to our knowledge.

c. The expressions W1, W2, etc. refer to Dr. *R. H. Wetmore*'s collection, made in 1921 and published in 1923. The numbers and names used below are according to Dr. Wetmore's list:

W1, Indian Harbour and adjacent islands. W2, island in Hamilton Inlet. W3, Double Mer (along the shores only). W4, barrens north of Rigolet. W5, north side of the Narrows (from the mouth of Double Mer to the east end of Lake Melville). W6, south side of the Narrows from opposite the mouth of Double Mer to the entrance to the Backway. W7, shores and neighbouring terraces of Mulliock Cove. W8, shores and adjacent territory at Caravelle Bay (near Eskimeau Island). W9, along Mulligan's River. W10, shores at Northwest River. W11, Grand Lake (shores only). W12, shores of Naskaupee River. W13, Hamilton River near Muskrat Islands. W14, shores and portage at Muskrat Falls, Hamilton River. W15, shores of the Kenemich River. W16, south side of Lake Melville from Carter Basin to English River. W17, barrens and mountains at English River. W18, shores and barrens at the Backway. W19, grass field at Mud Lake (Gillesport). W20, shores at Sabascachew Bay.

d. From the long list of Dr. *G. Gardner*'s collection in the 'thirties (mainly from an expedition in 1938) on the Labrador and Hudson Bay coast (GARDNER 1946) I have below combined the localities as follows:

G1, Niger Sound (south of Battle Harbour). G2, Battle Harbour. G3, Domino Harbour, Domino Run. G4, Gready (Grady) Islands (incl. Cape North on the mainland coast and several smaller islands). G5, Cut-Throat Island near Indian Harbour. G6, Dog Island (incl. Settlers Hut). G7, Winter Harbour south of Hopedale. G8, Hopedale. G9, Jack Lane Bay. G10, Windy Thickle. G11, Davis Inlet. G12, Port Manvers. G13, Cape Mugford.

e. Mrs. *Margaret T. Doutt* collected plants (1938) in the following localities along Hamilton River (see ABBE 1955), in order from Lake Melville to Sandgirt Lake above Grand Falls:

D1, Northwest River. D2, Muskrat Falls. D3, Sandy Banks above Muskrat Fall. D4, Porcupine Rapids. D5, Bull Island Rapids. D6, Horseshore Rapids. D7, mouth of Minipi River. D8, 10 miles above mouth of Minipi River. D9, opposite mouth of Cache River. D10, Winokapau Lake. D11, 16 miles above the mouth of Elisabeth River. D12, Big Hill Portage. D13, 2.5 miles above Big Hill Portage. D14, Lefthanded Lake. D15, Muskrat Lake. D16, Humbug Lake. D17, 5 miles above Grand Falls. D18, Grand Falls. D19, Flour Lake. D20, Sandgirt Lake.

Note that the localities H1 and G2 (Battle Harbour), H16 and W4 (Rigolet)[1], H20, W10 and D1 (Northwest River), H26 and W2 (Black Island), H30 and W1 (Indian Hbr.), H33 and TW3 (Ragged Islands), H44 and G8 (Hopedale), TW8 and G12 (Port Manvers), H50, TW9 and G13 (Kaumajet Mts.), are more or less identical, but as they comprise areas of different sizes visited by different collectors they are, therefore, kept apart here.

f. »*Mly Mt.*» refers to Dr. *W. Gillette*'s plant list from the rarely visited Mealy Mountains (about 4,300 feet above sea level) south of Lake Melville (GILLETTE 1954).

g. The expression »*Goose B.*» refers to various collections from the recently frequently visited area around Goose Bay. Dr. *A. E. Porsild* made there a small but valuable observation in 1944; reference to this notice is below marked Goose B. (P.). Mssrs. *A. Dutilly, E. Lepage* and *M. Duman* have also collected plants in the Goose Bay area, see their paper of 1953. The author spent only two days at Goose Bay, in 1952, including a short trip to lower Hamilton River, specimens from this trip are below marked »Goose B. (H.)». In 1952, Dr. *Weston Blake Jr.* made a study of the cover types in the west end of Lake Melville, including Grand Lake, lower Hamilton River, Naskaupee River, etc., and also collected the plants which are listed in his paper (BLAKE 1953). No specific data are given, however, for the plant localities mentioned; references to Blake's list are below marked only »Goose B. (B.)»; this expression includes a much wider area than the above-mentioned collections.

h. The abbreviation »*KL*» refers to the author's collection in 1948 in the Knob Lake area and its surroundings (Lake Ruth, Lake Wishart, Irony Mountain, Goodwood Mt., Lake Gillard, etc.; see H 1951). If later collectors, i.e. Dr. *Francis Harper*, Dr. *John Grayson*, Dr. *H. W. Vogelmann* or Dr. *Leslie Viereck*, have found species which were not noted by me, the collector's name is mentioned in brackets: »KL (Harper)», etc.

i. »*Attik.*» refers to Dr. *Francis Harper's* collection (1953) from Attikamatagen Lake northeast of the Knob Lake area.

[1] Cf. also H18 and W7.

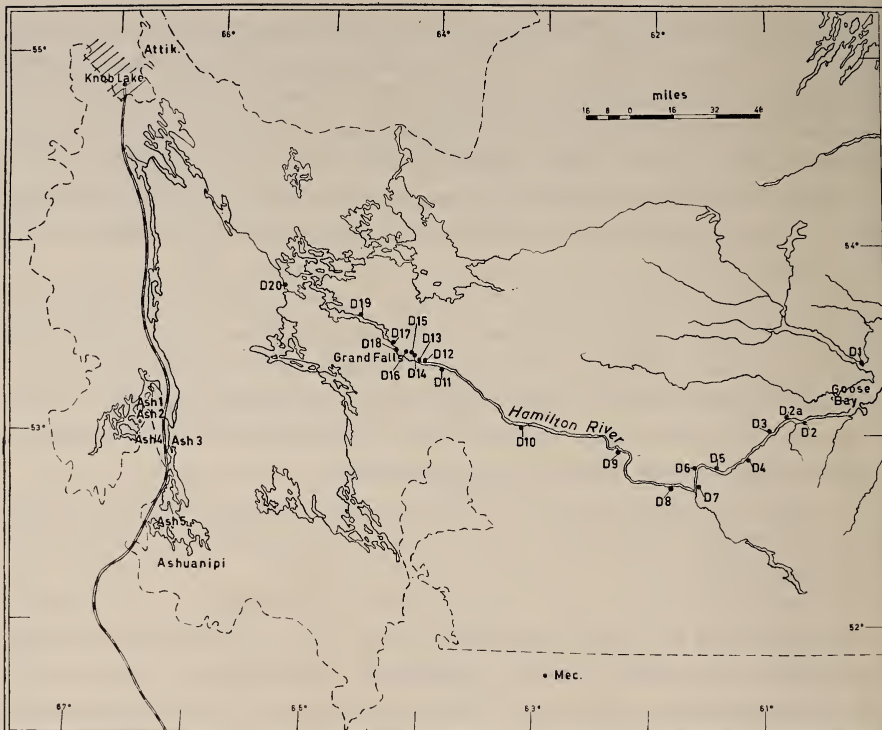


Fig. 2. Localities in the interior of Labrador.

j. »*Ash.*» refers to a series of small collections from the Ashuanipi area, which, however, can be approximately divided into the following localities: *Ash.* 1, Lorrain Mt. (2955 feet high, 53°06′ N, 66°57′ W). *Ash.* 2, Carol Lake (53°04′ N, 66°58′ W, incl. Downdraft Lake). *Ash.* 3, north end of Ashuanipi Lake, (53°00′ N, 66°15′ W), *Ash.* 4, »Mile 224» along the railway (including vicinity of Ashuanipi Lake), *Ash.* 5, sandy peninsula at the south end of Ashuanipi Lake. The collections from *Ash.* 1—3 were made in 1953 by Dr. *Francis Harper*, the »*Ash.* 4» collection from a bog area by Dr. *John Grayson* (see Grayson 1956). *Ash. 5* refers to a small collection by the author in 1948 (H 1951).

k. »*Mec.*» refer to the collection I made in 1952 during my ten days' stay on an island (51°50′ N, 62°53′ W, 1720 feet above sea -level) in Lake Morhiban; a radio-beacon called Mecatina was erected there.

l. If a place named as a plant locality from sources not mentioned above

(e.g. specimens in the National Museum of Canada, etc.) coincides with the list H 1—51, the expressions »Malte 10», »Wenner 31», etc., are used.

m. If the maps in PORSILD (1957) and HULTÉN (1958) give a different picture of the distribution of a species than the collections quoted in the list below, the maps are usually mentioned below, using the expressions »Porsild, map 101», »Hultén, map 51», etc[1].

The localities mentioned above can be divided into four groups according to their situation in relation to the coastline and the timbered area:

I. Outlying *capes, skerries and islets* without trees or conifer bushes: H1, H3—4, H6—9, H13, H26, H29—33, H39—41, H43, H48, TW 1—3, G1—5, W1—2.

II. Localities on the *coast of the mainland* or on *larger islands* off the coast within the »spruce brushwood region» (see H 1939); H5, H10—12, H14, H16—19, H22—25, H28, H34, H36, H38, H42, H44—47, TW4—7, G6—11, W3—8.

III. *Inland localities* in the timber forest region, even if sometimes near the coast: H2, H15, H20—21, H27, H35, H37, W9—20, D1—20, Mly Mt., Goose, Attik., KL, Ash. 1—5, Mec.

IV. The *arctic coast:* H49—51, TW8—9, G12—13.

Taxonomists and nomenclature:

The bulk of the author's 1937 collection was determined or checked by the well-known Finnish Botanist, Dr. *Bror Pettersson.* Many sheets had to be determined later, because of difficulties in obtaining reference material; the preliminary list (see HUSTICH-PETTERSSON 1944, p. 193) also contained some minor errors which are corrected below. After the war the undetermined material — if not missing by then — was determined by the following well-known specialists: Dr. *G. Haglund* (*Taraxacum;* marked G. H. below), Dr. *I. Hiitonen* (I. Hiit.), Prof. *E. Hultén* (*Euphrasia,* etc.; E. H.), Dr. *Jaakko Jalas* (*Oxytropis, Cerastium;* J.J.), Prof. Aarno Kalela (*Carices;* A.K.), Dr. *Gunnar Marklund* (*Alchemilla;* G.M.), Prof. *J. A. Nannfeldt* (*Poa;* J.A.N.), Dr. *A. E. Porsild* (*Antennaria, Draba* etc.; A.E.P.). Unfortunately, data for many common species are for some localities based only on field-notes. From most localities given in italics (*H16* etc.) there are specimen in the Botanical Museum of Helsinki; other numbers in my collection of 1937 refer to field notes only or to specimens determined at the time but for one reason or an other the sheets have been missing since the war.

---

[1] Unfortunately, MACOUN'S important list (1895) could not be used here, as only very general information is given re. the localities. Data re. the collections from LOW'S expeditions (1895) are included in PORSILD'S maps, see above.

The specimens brought home (1939) by Dr. *V. Tanner* were determined by Prof. *Harald Lindberg,* curator of the Botanical Museum, Helsinki; several sheets were later checked by Dr. *A. E. Porsild;* these specimens are in my collection in Helsinki. Dr. *C. G. Wenner*'s collection from 1939 was determined by the late Dr. *Th. Arwidsson;* the specimens are in the Naturhistoriska Riksmuseet, Stockholm.

Dr. *G. Gardner*'s large collection from the coast (mainly collected in 1938) was determined by Dr. *L. M. Fernald,* Dr. *O. Malte,* et al. (see Gardner 1946, p. 2). Dr. *R. H. Wetmore*'s plants (Wetmore 1923) were identified at the Gray Herbarium by Dr. *L. M. Fernald* et al. and Mrs. *Margaret T. Doutt*'s collection by Dr. *Ernst G. Abbe* (Abbe 1955).

My entire Knob Lake and Ashuanipi collections from 1948 were checked and a large part also determined by Dr. *A. E. Porsild* (see H 1951) as was also Dr. *Francis Harper*'s entire collections of 1953 from Attikamatagen, Knob Lake, etc. My small Mecatina and Goose Bay collections of 1952 were determined by Mssrs. *Marcel Raymond* and *H. J. Scoggan* in 1952; I belatedly express my gratitude. All my specimens from Knob Lake, Ashuanipi, Goose Bay and Mecatina mentioned in the list below are preserved in the National Museum of Canada and duplicates are also deposited in the Botanical Museum of Helsinki. Mr. *M. Raymond* also determined *Blake*'s and *Grayson*'s collections from Goose Bay, Knob Lake, etc. (see above). The *Salices* and *Carices* of the *Grayson* collection were determined by Dr. *C. Bell* and Dr. *W. Wagner,* respectively. Mr. *L. Viereck*'s collection of 1955 from Gerin Mt. (Knob Lake area) is deposited in the University of Colorado Herbarium.

Several persons have kindly supplied additional information in letters concerning the flora of Labrador: Mr. *W. K. W. Baldwin,* Ottawa, Dr. *Weston Blake Jr.,* USA, Dr. *Norman Drummond,* Montreal, Dr. *G. Gardner,* Montreal, Dr. *Francis Harper,* Chapel Hill, N.C., Prof. *Eric Hultén,* Stockholm, Ptre *Ernest Lepage,* Rimouski, P.Q., Dr. *A. E. Porsild,* Ottawa, Dr. *H. V. Vogelmann,* Hanover, N.H., Dr. *P. Wheeler, Jr.,* Cornell University, New York, Mr. *Leslie Viereck,* College, Alaska, and Mr. *W. C. Wilton,* St. John's, Newfoundland.

*

Nomenclature mainly follows *L. M. Fernald's* in Gray's Manual of Botany (8th ed., 1950). Earlier used names in various papers (including Hustich & Pettersson 1944, etc.) have been changed according to the usage of the Manual; however, in some cases names proposed and used by Porsild (1957) or Hultén (1958) have also been used in the list below.

*

The collections by the Moravian Brothers and others made in earlier years on the Labrador coast have in general not been used here, as I do not feel myself qualified to interpret the work of earlier taxonomists. There are also many genera and species which need much closer attention: *Carex, Agrostis, Salix, Betula, Equisetum, Dryopteris spinulosa-dilatata, Rubus acaulis, R. pubescens, Rhinanthus, Taraxacum,* etc. In a phytogeographic study we must avoid using unclear taxons. Fortunately, however, it seems that the commonest and, thus, ecologically and physiognomically most important species are also more clear-cut taxonomically (compare p. 32 below). This is a point which should be discussed more fully by geneticists.

The many hybrids of *Carices* and *Salices* that have been described are not included, cf. LEPAGE 1956.

I'm well aware that there are large and partly unpublished collections of plants from Labrador in the botanical museums of the USA and Canada. As, however, my purpose is only to provide a floristic background for a primarily phytogeographical and forest botanical study[1], the digging out of the museum material is left to more qualified taxonomists over there. I believe, however, that the general picture of the flora of Boreal and Subarctic Newfoundland-Labrador, as it appears in the following list, will not change very much. All the same, there is reason to quote the following words by *L. M. Fernald* (TANNER 1944, p. 416): »Nearly all the published lists of Labrador plants contain errors».

II. LIST OF VASCULAR PLANTS

Equisetum arvense L.: H*29*, *30*, *34*, 49, *50*; G4—6, 12, 13; Goose B.(B), D2; Attik., KL (Viereck).

E. pratense Ehrh.: H*49* (det B.P.); Attik (Harper).

E. sylvaticum L. (incl. v. *pauciramosum* Milde): H*10*, 12, 16, *34*, 36, 42, 44, 47; G4, 6; W4; Mly Mt.; D2, 18; Attik., KL, Ash. 3, 5, Mec.

E. palustre L.: W12 (Wetmore 1923, p. 5).

E. fluviatile L.: H34, *37*; D2, 3; KL, Ash. 3—5.

E. variegatum Schleich.: KL (H 1951 p. 202). — (*E. scirpoides* has probably not been found in the area, cfr. Porsild, map 7.).

Lycopodium Selago L.: H3, 4, 6—8, 22, *23*, 24, 27, 34—36, 38, 41—44, 47, 49, 51; G4, 7, 11, 13; KL; Ash. 1; Mec.

L. lucidulum Michx.: H*8* (det. B.P.; Hustich-Pettersson 1945, p. 31).

L. inundatum L.: Goose B. (acc. to Hultén, map 198); Ash. 4 (Grayson).

[1] To be published later.

L. annotinum L. (incl. v. *pungens* (La-Pylaie) Desv. and v. *acrifolium* Fern.); H4, 10, 12, 16, *24*, 27, 31, 36, 38, 42—44, 46, 47, 49, 51; G1, 6, 8; W4, 6, 9, 12, 14, Mly Mt., Goose B., D2, 18; Attik., KL, Ash. 1, 2, 4, 5, Mec.

L. clavatum L. (incl. v. *monostachyon* Grev. et Hook. and v. *megastachyon* Fern. & Bism.): H3—*5;* Goose B., D2; KL, Ash. 1.

L. obscurum L. v. *dendroideum* (Mich.) Eat.: H2, *28*, 37; W9; Goose B.(P); KL (Viereck).

L. sabinaefolium Willd. v. *sitchense* (Rupr.) Fern.: H*2*, *5*, *34*; Goose B.(H); D1, KL, Ash. 4.

L. alpinum L.: H35, 36, 44, 49; W7, Mly Mt., KL, Ash. 1.

L. complanatum L.: H4, *28;* G1; W12; Goose B.(B); D1, 2; KL, Ash. 2, Mec.

L. tristachyum Pursh: Goose B. acc. to Hultén, map 39.

Selaginella selaginoides (L.) Link.: H*34*, *35*, 37; Abbe 30; D20, KL, Ash. 4.

Isoëtes muricata Dur. (= *I. echinospora* Dur. v. *muricata* (Dur.) Engelm.): H1, *7;* Salmon Bight (Nat. Mus. Can.); D19, Ash. 1, Mec.—*I. echinospora* Dur. v. *Braunii* (Dur.) Engelm.: KL, cf. Hultén, map 235.

I. macrospora Dur.: H*37* (det. B.P.; Hustich-Pettersson 1945, p. 45).

Botrychium Lunaria (L.) Sw.: H10, *19;* G4; KL.

Osmunda Claytoniana L.: H*2;* W17; D3.

Woodsia ilvensis (L.) R.Br.: H3, 4, *34*, *36*, 41, 42, *44*, *47*, 50, 51; G4, 13; KL.

W. glabella R.Br.: H42, 51; Abbe 50; G13; KL.

W. Bellii (Lawson) Porsild: Nain. cf. Porsild 1945, p. 147.

Cystopteris fragilis (L.) Bernh.: H1, 4, *24*, *30*, 38, *41*, *42*, 43, 48, *49*—51; G13; KL.

C. fragilis v. *Dickiaeana* (Sim) Moore: H*42*, 51 (det. B.P.).

C. montana (Lam.) Bernh.: Attik. (Harper), KL; cf. Hultén, map 226, and Viereck 1957, p. 36.

Onoclea sensibilis L.: H*2*; D3.

Dryopteris disjuncta (Ledeb.) C.V. Mort.: H4, 5, 10, 16, 23, 25, 31, 34, 36, 38, 42, 43, 45; G1, 4; W4, 6; Mly Mt., Goose B.(B); D2, 18; Attik., KL, Ash. 2.

D. Phegopteris (L.) Christ.: H1, 4, 7, 27, 31, 32, 34, 35, 38, 41, 42, 44, 47, 51; G2, 10; W1, 14, 17; D2, 10; Attik., KL, Ash. 3.

D. spinulosa (O.F.Muell.) Watt. v. *americana* (Fisch.) Fern.: H*15* (field notes from nineteen loc. on the coast); G4; W6, 17; D18; Goose B.(B), Mly Mt; Attik, KL, Ash. 1, 2, Mec. — *D. dilatata* (Hoffm.) A.Gray ssp. *americana* Fern. is acc. to Hultén, map 156, the more common plant in the area; Hultén stresses the multitude of variations in this complex, cf. Britton 1962.

D. fragrans (L.) Schott.: note Delabarre 1902, p. 193, and Porsild, map 5 (Holton?).

Athyrium Filix-femina (L.) Roth. v. *Michauxii* (Spreng.) Farw.: H1, *34*, *42* (det. I.Hiit.), Nutak (Tanner 1944, p. 382); G4; W17; D18; also W of Ashuanipi (Löve et al. 1958, p. 57).

A. alpestre (Hoppe) Rylands. (v. *gaspense* acc. to Hultén, map 223): H27, 28, *38*, *42* (det. B.P.).

(*Pteridium aquilinum* (L.) Kuhn. v. *latiusculum* (Desv.) Underw.: Sandwich B. (Wilton 1960, p. 16), Goose B.(Blake 1953). Uncertain data.

Abies balsamea (L.) Mill.: H2, 4, 5, 10, 15—18, 20, 21, 25, 28, 31, 34—38, 41, 42, 44, 47; TW1, 2; G1, 4, 5; W3—20; Goose B., Mly Mt., KL, Ash. 3—5, Mec.

Picea glauca (Moench.) Voss.: H10, *17*, *47*, *49;* Goose B., Hamilton R., KL, Ash. 4.

P. mariana (Mill.) BSP.: H2, *10*, *16*, *17*, 20, 23, 24, 27, 37; TW2; G1, 4; Mly Mt., Goose B., KL, Ash. 2, 4, 5, Mec.

Larix laricina (DuRoi) K.Koch: H4, 5, *10*—12, 14—18, 22—25, 27, 28, 34—38, 44—46, *47;* G1, 4, 6—9, 11; Mly Mt., Goose B., KL, Ash. 4, 5, Mec.

Juniperus communis L. (incl. v. *depressa* Pursh., and v. *saxatilis* Pall.): H3—5, 7, *17*, 28, 34—36, 38, 41, 42, 44, 47; G4, 5, 7, 10; W18; D1, 8; Goose B., Attik., KL, Ash. 2.

Sparganium angustifolium Michx.: H2, *34* (det. A.E.P.); Battle Hr., Hopedale (Nat. Mus. Can.); G4; W9; D12; KL; Ash. 3. Cf. Hultén, map 195.

S. hyperboreum Least.: H*44* (det. A.E.P.); G4; Abbe 30; Nain, Okak, Harrigan, Cut-throat Isl. (Nat. Mus. Can.); KL.

S. minimum (Hartm.) Fr.: Goose B. acc. to Hultén 1962, p. 102—3.

Zostera marina L.: H*21* (det. B.P.; Hustich-Pettersson 1945, p. 43).

Potamogeton filiformis Pers. v. *borealis* (Raf.) St.John: H20; Nain (Nat. Mus. Can.); KL (probably also Ash. 5); cf. Hultén, map 242.

P. alpinus Balb. v. *tenuifolius* (Raf.) Ogden: D12; Attik., KL.

P. gramineus L.: H*37;* W12; KL, Ash. 3.

P. Oakesianus Robbins.: H*2* (det. B.P.; Hustich-Pettersson 1945, p. 43).

P. praelongus Wulfen.: Ash. 2 (Harper).

P. Richardsonii (Benn.) Rydb.: D17, KL.

P. perfoliatus L. v.*bupleuroides*(Fern.) Farw.: KL (Harper 1958, p. 36).

Ruppia maritima L.: H*21* (det. B.P.; Hustich-Pettersson 1945, p. 43.)

Triglochin maritimum L. s.l.: H*12*, 31, *34*, *43*, 47; Goose B., KL, Ash. 2, 3.

T. palustris L.: H*34*, 35 (det. B.P.); Abbe 44; G1; Ash. 4.

Scheuchzeria palustris L. v. *americana* Fern.: D6, 12, Goose B.(B), Mec.

Bromus inermis Leyss.: Goose B.(H; det. H.J.S.).

Schizachne purpurascens (Torr.) Swallen: KL(H 1951, p. 204).

Festuca brachyphylla Schultes: H18, *30*, *34*, 42, 48, *50*; Abbe 44, TW6; KL (approaching *F. saximontana* Rydb., see H 1951, p. 204. Cf. Abbe 1936, p. 142—43).

F. vivipara (L.) Sm.: H1, *7*, *31*, *42*.

F. rubra L. coll.: H4, 7, 13, 14, 16, *17*, 19—*21*, *25*, 33, *34*, *38*, 39, 41, 42, 44, 46, 47; G4, 6; W5, 6.

Puccinellia coarctata Fern. & Weath.: Hultén, map 262 (S of Domino Isl.).

P. Langeana (Berl.) Th.Sør. ssp. *typica:* H*39* (det. A.E.P.). Cf. Porsild, map 49 (three loc. on the coast).

P. paupercula (Holm.) Fern & Weath. v. *alaskana* (Schribn & Merr.) Fern. & Weath.: H*34*, *39* (det. A.E.P.).

P.phryganodes (Trin.) Schribn. & Merr.: H*19*, *21* (det. B.P.); G4. Cf. Abbe 1936, p. 142.

P. vaginata (Lge) Fern. & Weath. v. *paradoxa* Th.Sør.: Hebron (?), Porsild, map 52.

Glyceria borealis (Nash.) Batchelder: H*2* (det. B.P.); W11.

G. striata (Lam.) Hitchc. v. *stricta* (Scribn.) Fern.: H*34* (det. B.P.); W12; Goose B. (H, det. H.J.S.); KL.

Dupontia Fischeri R.Br. ssp. *psilosantha* (Rupr.) Hult.: Porsild, map 44 (three loc. on the coast).

Arctophila fulva (Trin.) Anders.: D1 (Abbe 1955, p. 30), an extension of range acc. to Porsild, map 41.

Poa annua L.: H*10*, 20, 34.

P. pratensis L. s. l.: H*10, 20, 21, 31* (det. J.A.N.); G3, 4; W5, 6, 14, 19; Goose B. (H), KL. Partly introd. — *P. pratensis* »ad v. *subcoeruleum*» (det. J.A.N.): H*30*.

P. alpigena (Fr.) Lindm. f.: H*10, 16, 20, 25, 30, 39, 44, 50* (all *P. pratensis* v. »*alpigena*» acc. to J.A.N.); Attik., KL.

P. nemoralis L.:H*10, 20* (det. J.A.N.); KL.

P. palustris L.: GooseB. (H; det. M.R.).

P. alpina L.: H42, *44*, 47, *50*, 51; TW9; G12, 13; D18; Attik., KL.

P. gaspensis Fern.:TW9 (det.A.E.P.), new for the area.

P. glauca Vahl. coll.: H*10, 16, 20, 41, 42*, 51; Abbe 50; TW9; G4, 5; Attik., KL.

P. arctica R.Br.: Abbe 50; TW9; G12; KL (Viereck) — P. cfr. *arctica* (det. J.A.N.): H*30, 50, 51*.

P. compressa L.: Goose B. acc. to Hultén 1962, p. 218—18.

P. labradorica Steud.: G13 (Gardner 1946, p. 7), see also Dutilly et al. 1958, p. 59, and Polunin 1940, p. 77 (Hebron)?

P. eminens C.B.Presl.: H1, 10, 12, 13, *15*—19, 31, *34*, 45, 46; TW4; G4, 12; W5, 6, 9.

Phippsia algida (Sol.) R.Br.: Two loc. on the coast, cf. Porsild, map 16.

Catabrosa aquatica (L.) Beauv. v. *laurentiana* Fern.; G4 (Gardner 1946, p. 7; Goose B. (Porsild 1944 p. 4). Cf. Hultén, map 52.

Agropyron trachycaulum (Link.) Malte v. *majus* (Vasey). Fern.: H*34, 36*, 37; KL.

A. trachycaulum v. *novae-angliae* (Scribn.) Fern.: Ash. 3 (Harper).

A. violaceum (Hornem.) Lge: KL (Viereck 1957, p. 37).

A. repens (L.) Beauv.: H1, 20.

Hordeum jubatum L.: H10; Wenner 42; W12. Introd at 10?

Elymus arenarius L. v. *villosus* Mey.: H1, 3, 4, 7, 10, 12, 13, 15—19, 21, 22, 24, 25, *30*, 31, 33—35, 38—41, 43, 44, 46, 48, 51; TW2; G1, 2, 4, 9; W1—3, 5—8, 10, 16—18; D1.

Trisetum spicatum (L.) Richter v. *Maidenii* (Gandoger) Fern.: H1, *20*, 49, *50*—51. — *T. spicatum* v. *molle* (Michx.) Beal: D2; Attik. KL. — *T. spicatum* v. *pilosiglume* Fern.: H1, 23, 31, 34, *35*, 38, *41*, 42, *44*, 46, 48; TW9.

Deschampsia flexuosa (L.) Trin. (incl. v. *montana* (L.) Ledeb.): H1, 3, 4, 8, 10, *22*, *31*, 34—36, 38, 40, 42, 44, 51; G13; TW2; W3, 6; D12, 18; KL, Ash. 3.

D. caespitosa (L.) Beauv.: *20* (det. B.P.); KL (Viereck). — *D. caespitosa* v. *glauca* (Hartm.) Lindm. f.: KL.

D. alpina (L.) R. & S. (a variety of *D. caespitosa?*): Hultén, map 203 (Hebron), cf. Woodworth 1927, p. 55.

D. atropurpurea (Wahlenb.) Scheele: H*31*, 32, 34—36, *38*, 49; KL.

Danthonia spicata (L.) Beauv.: H34, *40, 44* (det. B.P.).

D. intermedia Vasey: Makkovik (Bishop 1930, p. 61), Ash. 2 (Harper).

Calamagrostis canadensis (Michx.) Nutt.: H*10* (20, 25); G4, 9; Hopedale

(v. *robusta* Vasey, Stebbins 1930, p. 42); Goose B; D2, 3; KL, Ash. 3, 5; Mec.

C. Langsdorffii Trin.: H*10*, *34*, *44*; G4; W1, 5, 6, 8, 11; Attik. KL.

C. inexpansa A.Gray (incl. v. *brevior* (Vasey) Stebbins): KL (H 1951, p. 204).

C. lapponica (Wahlenb.) Hartm. v. *nearctica* Porsild: KL (H 1951, p. 204; probably also at H*10*, det. A.E.P.).

C. neglecta (Ehrh.) Gaertn.: Mey & Scherb.: H1, *10*, *11*, 19, *24*, *31*, *34*, 47; G4; W4, 5, 10, 12; KL, Ash. 3. — *C. neglecta* v. *borealis* (Laest.) Kearney: Goose B. (H; det. H.J.S.).

C. labradorica Kerney: SE-Labrador, acc. to Stebbins 1930, p. 53.

Agrostis alba L.: D2 (Abbe 1955, p. 30).

A. tenuis Sibth.: W19 (Wetmore 1923, p. 6).

A. scabra Willd. v. *septentrionalis* Fern.: H27, 28, *34*, 36, 37; Ash. 5.

A. hyemalis (Walt.) BSP.: W12, 14 (Wetmore 1923, p. 6, probably *A. geminata*).

A. geminata Trin.: D10 (Abbe 1955, p. 30).

A. canina L.: Cartwright (Nat. Mus. Can.). Introd.?

A. borealis Hartm.: H4, 7, *10*, 11, 16, *23*, 27, 29, 31, 34, 38, *39—42*, *44*, *47*, 50; Abbe 1; G9, 12, 13; KL, Ash. 1, 5.

Cinna latifolia (Trev) Griseb.: W10, 14; D2; Goose B. (H; earlier Porsild 1944, p. 5).

Phleum pratense L.: H20; W14, 19; Goose B. (H).

P. alpinum L.: H20; W1; KL (Viereck).— Incl. *P. commutatum* Gand.; see Böcher 1954, p. 79 and Hultén 1958, p. 234.

Alopecurus aequalis Sobol; KL. — *A. aequalis* v. *natans* (Wahlenb.) Fern: G4; D20.

A. alpinus L.; Porsild, map 15 (along the coast down to Okak).

Oryzopsis canadensis (Poir.) Torr.: Ash. 3 (Harper).

Hierochloe odorata (L.) Beauv.: H10, *14*, 16, 18, 19, *29*, 43; G4, 6; Ash. 3.

H. alpina (Sv.) R. & S.: H*23*, 27, *30*, 31, 35, 38, 41, 42, 44, 47—*49*, *50*, 51; Abbe 1; G9, 12; W1; Mly Mt.

H. orthantha Th.Sør.: Salmon Bight, Turnavik, Indian Hr. (Nat. Mus. Can.).

Eleocharis acicularis (L.) R & S.: H2, 34, *37* (=v. *submersa* (Hj.N.); W12, D12.

E. palustris (L.) R & S.: W9 (Wetmore 1923, p. 7).

E. halophila Fern. & Brack.: One loc. in Labrador (acc. to Porsild, in letter).

E. uniglumis (Link.) Schultes; H*20* (det. B.P.); Sandwich B. (Bishop 1930, p. 61).

E. kamtschatica (C.A.Mey) Kom.: Sandwich B. (Dutilly et al. 1958, p. 82).

Scirpus cespitosus L. v. *callosus* Bigel: H1, 3, 4, 8, *10*, 16, 17, 27, 31, 34, 35, 42, 44, 47, *50*, 51; G2—4, 11; W1; Mly Mt., D12, 18, Kl. Mec.

S. hudsonianus (Michx.) Fern.: H *34*, 36, 37; Attik., KL, Ash. 4.

S. rubrocinctus Fern.: W11; D3 (Abbe 1955, p. 31).

S. atrocinctus Fern.: H *2*; W12; Goose B. (H; det. M.R.).

Eriophorum Scheuchzeri Hoppe: H1, 4, 6, *10*, 24, 43, 44; TW1, 5; G2—4, 8, 12; W1.

E. russeolum Fr.: H1, 4, *10*, *31*, 34, 36, 42, *43*, *44*, 45; TW7; G4; W6; D12, 18; Attik., KL, Ash. 4.

E. brachyantherum Trautv. & Mey.: G7 (Gardner 1946, p. 8); KL (Har-

per and Viereck). Cf. Raymond 1950 a, p. 32.

E. callitrix Cham.: W4 (Wetmore 1923, p. 7 =*E. spissum*?).

E. spissum Fern.: 15, *23*, 27, 34, 35, 38, 41, 42, 44, 47; Abbe 1; TW2 G1, 4, 9, 11; Mly Mt., Attik., KL, Mec.

E. gracile W.D.J.Koch: W10; Goose B.(B), Ash. 3.

E. tenellum Nutt.: Ash. 3 (Harper 1958, p. 74).

E. angustifolium Honckeny: H4, 7, 8, 27, 31, 34—36, 38, 41—45, 47, 51; TW8; G3—6, 8, 12; W1, 17; D12, 18, KL.

E. viridicarinatum (Engelm.) Fern.: Attik., KL, Ash. 2 (Harper).

E. virginicum L.; Goose B. (Porsild 1944, p. 4). Coll. by Tanner 1939 in the Grand Lake area (det. A. E. P.).

Kobresia scirpina Willd.: H*34*, *50;* cf. Raymond 1950 b, p. 441.

K. simpliciuscula (Wahlenb.) Mack.: Porsild, map 70 (Battle Hr?).

Rynchospora alba (L.) Wahlenb.: Goose B. (Porsild 1944, p. 4).

Carex nardina Fr. v. *atriceps* Kük.: KL (H 1951, p. 205).

C. capitata L. v. *arctogena* (H.Smith) Hult: H*10*, 22, *23*, *34*, 35, 41, 45; KL, Ash. 1.

C. gynocrates Wormskj.: H*30*; Hopedale (Bishop 1930, p. 61); Attik., KL. Cf. Raymond 1950 b, p. 442.

C. maritima Gunn.: H*30* (det. A.K.).

C. Langeana Fern.: H*34* (det. A.K.; Hustich-Pettersson 1945, p. 39.).

C. stipata Muhl.:W12 (Wetmore 1923, p. 7).

C. disperma Dew.: D18; Attik., KL.

C. trisperma Dew.: H*15*, *34;* D12; 18; KL, Mec.

C. tenuiflora Wahlenb.: KL (H 1951, p. 205; also Viereck 1957, p. 67).

C. Lachenalii Schk.(*C. bipartita* Bell.): H8, 30, *31*, *38;* TW9; KL.

C. glareosa Wahlenb. (*C. bipartita* v. *glareosa* (Wb.) Polunin): H12, *15*, *19* (— *C. marina* Dew., det. A.K.), 21, 34; G4.

C. glareosa v. *amphigena* Fern. (*C. bipartita* v. *amphigena* (Fern.) Polunin): G4, W5, 6. Cf. Porsild, map 82 (several loc. on the coast).

C. Mackenziei Krecz.: Hultén, map 274 (Hopedale ?).

C. Heleonastes Ehrh. KL (H 1951, p. 205; cf. Böcher 1952, p. 27).

C. canescens L.: H*15*; G4, 9; W10; D1, 2, KL (v. *subloliacea* Laest.), Ash. 2.

C. brunnescens (Pers.) Poir.: H*15;* G4; W5, 6, 14; D1, 4, 10, 12; Attik. KL, Ash. 4, Mec.

C. arcta Boott.: KL (H 1951, p. 206).

C. Deweyana Schwein.: S-Labrador, acc. to Fernald 1950, p. 315.

C. exilis Dew.: Makkovik (Bishop 1930, p. 62); Goose B.(P); D12; Ash. 2, 4.

C. interior Bailey: KL (H 1951, p.206; might be an error, acc. to M.R.).

C. angustior Mackenz. (= *C. echinata* Murr. v. *angustata* (Carey) Bailey: H*34;* W14; D9, 12; KL (Viereck), Ash. 3.

C. sterilis Willd.: G4 (Gardner 1946, p. 9).

C. atlantica Bailey: G4 (Gardner 1946, p. 9).

C. macloviana d'Urv.: H*31*; G13; TW9. Cf. Raymond 1951, p. 7—8.

C. aenea Fern.: H*20* (det. A.K.). Coll. by Tanner 1939 in the Grand Lake area (det. A.E.P.).

C. praticola Rydb.; Goose B. (H; det. M.R.).

C. leptalea Wahlenb.: H*34;* Attik., Ash. 2 (Harper).

C. projecta Mack.: W12 (Wetmore 1923, p. 7).

C. Crawfordii Fern.: Goose B. (Dutilly et Lepage 1951, p. 48).

C. argyrantha Tuck.: Goose B. (H; det. M.R.).

C. rupestris Bellardi: H*49*. Cf. Porsild, map 75 (one loc., Hopedale?).

C. scirpoidea Michx.: H*31;* G3, 4, 12; KL.

C. deflexa Hornem: H*23;* KL, Mec.

C. abdita Bickn.: Goose B. (H; det. M.R.).

C. concinna R.Br.: KL (H 1951, p. 206).

C. terra-novae Fern (= *C. glacialis* Mack. = *C. pedata* Wahlenb.): H*44, 51;* KL (H 1951, p. 206, also found by Viereck). Cf. Porsild map 91.

C. paleacea Wahlenb.: H*10*, 12, *14*, *15*, 21, *28*, *34*, 35; G2—4; W5, 6, 12.

C. aurea Nutt.: Turnavik (Nat. Mus. Can.).

C. salina Wahlenb. (= *C. subspathasea* Wormskj.): H*14* (det. A.K.). Probably new for the area, cf. Hultén, map 263.

C. recta Boott. (= *C. salina* v. *kattegatensis* (Fries) Almq.): G4, 6; W12. Cf. Hultén, map 264.

C. Lyngbyei Hornem.: Gready Island (Bishop 1930, p. 62).

C. aquatilis Wahlenb.: H*47;* G3, 4; D2, 18; Goose B.(B), Attik., KL.

C. Bigelowii Torr.: H3, 4, 6—8, *10*, 11, *16*, 22, 24, 26, *27*—29, *31*, 32, 34—36, 38, 41—45, 47—49, 51; G3—6, 9, 11—13; W11; Mly Mt.; D7, 12; KL, Ash. 1.

C. nigra (L.) Reich.: KL (H 1951, p. 206 = *C. Goodenoughii* Gay).

C. lenticularis Michx.: W10; Goose B. (H; det. H.J.S.); Attik.

C. stylosa C.A.Mey.v. *nigritella* (Drej.) Fern.: H*31*, *36;* D18; KL.

C. angarae Steud.(= *C. media* R.Br.): H34; Attik., KL (Viereck).

C. norvegica Retz. v. *inserrulata* Kalela: H*41*, *49;* G11; KL. Cf. Hultén, map. 74.

C. atratiformis Britt.: H1, 34, 41, *44;* G4; KL.

C. Buxbaumii Wbg.: Hultén, map. 254 (one loc., from Okak?).

C. polygama Schkur. ssp. *alpina* Caj. (= *C. adelostoma* Krecz.): H*51*(det. A.K.). Cf. Raymond 1951, p. 10—11. — *C. Morresseyi* Porsild: Okak, Cut-throat Isl. (Nat. Mus. Can.).

C. misandra R.Br.: H*44*, *50;* Abbe 50; G4. Cf. Raymond 1951, p. 4.

C. atrofusca Schk.: H*44* (det. A. K.).

C. rariflora Wahlenb. Sm.: H*10*, *14*, *15*, 18, *30*, *38*, 51; G1—4, 6, 9; Mly Mt., KL, Ash. 4.

C. limosa L.: H*34;* D12; KL.

C. paupercula Michx. (incl. v. *irrigua* (Wahlenb.) Fern.): H1, 4, 8, 10, 16, 17, 27, *34*, *36*, 37, 41, 45; Goose B.; D2, 12, 18; KL, Ash. 1, 3, 4, Mec.

C. lasiocarpa Ehrh. v. *americana* Fern.: Ash. 3 (Harper).

C. capillaris L. S.l.: H3, *30*, 31, 34—*36*, 38, *41*—43, 47, 49, *50*, 51; Abbe 1; TW9; Attik., KL.

C. williamsii Britt.: Cutthroat Isl. (Nat. Mus. Can.).

C. vaginata Tausch.: H*34*—36, 38, 44; Attik., KL, Ash. 2.

C. livida L. v. *Grayana* (Dew.) Fern.; Makkovik (Bishop 1930, p. 62); Attik., KL (Viereck 1957, p. 66).

C. Oederi Retz. v. *viridula* Kük.: KL (H 1951, p. 206); also coll. at Sandwich B. (H10, 14, 15), but specimens lost.

C. microglochin Wahlenb.: D12 (Abbe 1955, p. 32).

C. pauciflora Lightf.: H4, 10, 11, 16, 17, 27, 37; D18; KL. Ash. 3, Mec. Cf. Raymond 1950b, p. 441.

C. rostrata Stokes: W12; D2, 3, 12, KL. Ash. 3, 4. — *C. rostrata* v. *utriculata* (Bott.) Bailey: H*23*, *35*, *37* (det. A.K.).

C. oligosperma Michx.: H*37;* D12; Ash. 2, 3, Mec.

C. vesicaria L.: H*2* (v. *monile* (Tuck.) Fern.); W10, 20; KL, Ash. 5, Mec.

C. saxatilis L. v. *rhomalea* (Fern.) Mack.: H*30*, *31*, *37*, *44* (det. A.K.).

C. miliaris Michx.: W11, 14; D2; Attik., KL, Ash. 3—5. — *C. miliaris* v. *ungavensis* Raymond and *C. miliaris* v. *major* Bailey reported by Viereck (1957, p. 67) from KL.

C. rotundata Wg.: TW1 (Wenner's coll.). Cf. Raymond 1957, p. 175.

C. membranacea Hook. (= *C. membranopacta* Bailey):H*51* (det.A.K.): an extension of area, cf. Porsild, map 101.

Calla palustris L.: H*2;* D12 (Abbe 1955, p. 32).

Eriocaulon septangulare With.: H*2;* Goose B. (acc. to Hultén, map 188).

Juncus bufonius L.v.*halophilus* Buch. & Fern.: H*13*, *20* (= *J. ranarius* Perr. & Song., det. B.P.; cfr. Fagerström 1949, p. 203).

J. trifidus L.: H3—5, 7, 27, 31, 32, 34, 35, 44, 47, 51; W1; Mly Mt., KL.

J. tenuis Willd.: Goose B. (Dutilly et al., Nat. Mus. Can.).

J. Vaseyi Engelm.: Goose B.(H; det. M.R.; cf. Dutilly et Lepage 1951, p. 48).

J. filiformis L. (incl. v.*pusillus* Fries): H1, 4, 7, *10*, *34*, 37, 41; G4; W10, 12; Goose B.(B), D1, 2; KL, Ash. 2, 3, 5.

J. balticus Willd. v. *littoralis* Engelm.: H*20*, *25*, *34*, 37; G4, 12; W14, 20; D1, 2.

J. arcticus Willd.: G2, 6 (Gardner 1946, p. 11), Fraser R. (Bishop 1930, p. 62.

J. stygius L. v. *americana* Buch.: H*34* (det. A.E.P.); D12.

J. albescens (Lange) Fern. (= *J. triglumis* L.): H*30*, *34*, *38*, *47*; TW9; G5, KL.

J. castaneus Sm.: H*34*, 49, 51; G12, KL.

J. brevicaudatus (Engelm.) Fern.: H*2*, *34;* Sandwich B.(Woodworth 1927); D3, 12.

J. alpinus Vill. v. *rariflorus* Hartm.: H*34* (*J. nodulosus* Wg.); W11, 12 (v. *insignis* Fr.).

J. pelocarpus Mey.: D12 (Abbe 1955, p. 33).

J. subtilis Mey.: H*8* (det. B.P.; Hustich-Pettersson 1945, p. 31.)?

J. biglumis L.: H*50*, *51* (det. B.P.).

Luzula parviflora (Ehrh.) Desv.: *16*, 24, 25, 28, 31, 34, 36, 38, 42, 47, 49, *50*, 51; G12; D2, 12; Attik., KL, Ash. 1, Mec.

L. spicata (L.) DC.: field notes from sev. loc. but no specimen preserved in 1937; TW6; G3, 12; W1; KL (Viereck).

L. confusa Lindeb. (incl. *L. arcuata* (Wbg.) Sm.): H*26*, 34, *42*—*47*—*50*, 51; TW9; G5, 9, 12; Mly Mt., KL.

L. multiflora (Retz.) Lej. ssp. *frigida* (Buch.) Sam. v. *contracta* Sam.: H*10*, *16*, *34*, (det. A.E.P.); KL.

Tofieldia pusilla (Michx.) Pers.: H7, *30*, 31, 35, 38, *40*, 41, 43, 47, 49, *50*, 51; TW5, 7; G1, 12, 13; Mly Mt.; Attik., KL, Ash. 3.

T. glutinosa (Michx.). Pers.: KL (H 1951, p. 207).

Clintonia borealis (Ait.) Raf.: H3—*5*, *7*, *15;* W14, 17, Goose B. (Dutilly & Lepage 1951, p. 47); KL (Astray Lake, Vogelmann), Ash. 2.

Smilacina trifolia (L.) Desv.: H1—4, 8, *10*, *15*, *16*, 28, 34; G1—4, 6; W (»common»): D2, 18; Attik., KL, Ash. 3, Mec.

Maianthemum canadense Desf.: H1—4, 11, *20*; W11—15, 17; Mly Mt., Goose B.(Dutilly & Lepage 1951, p 47 and Wilton 1959, p. 28). Also in Hettasch' coll. from Nain (1937).

Streptopus amplexifolius (L.) DC. v. *americanus* Schultes: H3, 4, 7, 8, 10, 11, *15*, *28*, 32, *34*—38, 41, 42; TW4; G4; W16, 17; Goose B.; D2, 18; Attik., KL, Ash. 2, Mec.

Veratrum viride Ait.: Ash. 2 (Harper); cf. Löve et al. 1959, p. 61.

Allium Schoenoprasum L. v. *sibiricum* (L.) Hartm.: Cartwright (Malte, Nat. Mus. Can.).

Sisyrinchium montanum Greene v. *crebrum* Fern.: W19; cf. Hultén, map 189 (up to Lake Melville area) — *S. angustifolium* in Hettasch' coll. (1937) from Hopedale is *S. montanum* ?

Iris Hookeri Penny: H1, 3, 4, *10*, *14*, 17, 18, 21, 24, 25, 31, 40, 41, 43, 44; G1, 4, 6, 7; W1—3, 5—8, 16—18, 20.

I. versicolor L.: Sandwich B. (Woodworth 1927); D10; Goose B. (Dutilly & Lepage 1951, p. 47); Ash. 3 (Harper 1958, p. 19).

Habenaria hyperborea (L.) R.Br.: W 15; KL.

H. dilatata (Pursh.) Hook.: H1, *31*, *34*, 36—38; D19; Attik., KL, Ash. 2, 3.

H. obtusata (Pursh.) Richards. (incl. v. *collectanea* Fern.): H*15*, 27, *30*, 31, *41*, *43*; G4, 5, 7, 12; Attik., KL.

Spiranthes Romanzoffiana Cham. & Schlecht: W19; Ash. 4 (Grayson). Cf. Hultén, map 190.

S. cernua (L.) Richards: H34, *37* (det. B.P.).

Goodyera repens (L.) R.Br. v. *ophioides* Fern.: W17; D12.

Listera cordata (L.) R.Br.: H31, 34, 41; W17; D18; KL.

L. auriculata Wieg.: D9 (Abbe 1955, p. 34).

Corallorhiza trifida Chat.: Abbe 30; Hopedale (Bishop 1930, p. 62); D4.

Salix lucida[1] Muhl. v. *angustifolia* Anderss.: W11; Goose B. (Lepage; in letter); D3. — Re. *S. lucida* v. *intonsa* Fern., see Raup 1943, p. 94.

S. interior Rowlee; Goose B. (H., det. H. J. S.); see Raup, 1943, p. 94.

S. vestita Pursh: H1, 30, 31, 35, 41, 49—51; TW5, 8; G12, 13; D18 (v. *erecta* Anderss.); KL, Ash. 2.

S. reticulata L.: Mentioned by Tanner 1944, p. 363 from Indian Hr and by Abbe 1936 from N-Labrador; cf. Raup 1943, p. 94.

S. herbacea L.: H1, 7, 8, 27—29, 31, 32, 34—39, 42—44, 47—51; G4—7, 12; Mly Mt., KL.

S. Uva-ursi Pursh: H1, 10, 26, 30, 40, 42, 48, 50, 51; TW8, 9; G4, 13; Mly Mt., KL.

S. arctophila Cockerell: H26, 43; Abbe 1, 30; TW5; G4—7, 9, 11—13; Mly Mt., D18; Attik., KL (Viereck). Cf. Raup 1943, p. 101 (about twenty loc. from the area).

S. arctica Pall. coll. (incl. *S. anglorum* and *S. arctica* v. *kophophylla*): H29, 44; Abbe 1, 44, 50; W1; KL, Re. the *S. arctica*-complex, see Raup 1943, p. 98—100.

S. glauca L. coll.: (H 19, 26?); TW5; KL (H 1951, p. 208). Acc. to Raup 1943, p. 103—105 true *Salix glauca* L. is not found in Labrador.

S. cordifolia Pursh v. *callicarpaea*

---

[1] All the *Salices* from the 1937-collection (only partly mentioned in Hustich-Pettersson 1944—45), determined and undetermined were lost during the war. Raup's paper of 1943, fortunately, covers well this area.

(Traut.) Fern.: H31, 43, 50; TW1, 3 (= *S. Waghornei*), 5; G1, 2, 4, 7, 13; D18; Attik., KL. — *S. cordifolia* v. *Macounii* (Rydb.) Schneider: Abbe 30; KL (Viereck). Cf. Raup 1943, p. 105—108, who mentions about twenty loc. from the coast.

S. pyrifolia Anders.: G1; D3, 12. Acc. to Raup (1943,p.112) some add. loc. from the coast.

S. myrtillifolia Anders.: KL (Viereck 1957, p. 45); New for the area (?); not mentioned by Raup, l.c.

S. adenophylla Hook: Goose B. (H., det. H.J.S.); new for the area (?); not mentioned by Raup, l.c.

S. Bebbiana Sarg.: Sandwich B., Hamilton R. (Raup 1943, p. 117); Goose B. (B.), KL, Ash. 5, Mec.

S. calcicola Fern. & Wieg; Cape Mugford (Abbe 1936, p. 148).

S. pedicellaris Pursh v. *hypoglauca* Fern.: D12; KL, Ash. 4.

S. discolor Muhl.: D12; KL (Grayson).

S. humilis Marsh. (incl. v. *keweenawensis* Fern.): G1; Goose B. (B); D1, 3; Ash. 2, 5.

S. candida Willd.: Sandwich B. (Raup 1943, p. 115); Goose B. (Porsild 1944, p. 5).

S. planifolia Pursh: Common along the coast acc. to Raup 1943, p. 120 and my field notes of 1937 re. *S. »phylicifolia»;* G1, 4, 6, 7, 9—13; W18; D1, 7, 18; Attik., KL, Ash. 2—5, Mec.

S. pellita Anders.: D2, 12; Goose B. (H; det. H.J.S.); KL, Ash. 2, Mec.

S. argyrocarpa Anders.: TW5; G6, 7; Raup's map (l.c.) shows several loc. on coast; Mly Mt., D2, 12, 18; Attik. KL (Viereck, Grayson) Mec.

Populus tremuloides Michx.: H2, (15); Goose B.; D1, 3, 4, 7, 12; W9, 12; Ash. 4, Mec.

P. balsamifera L. (incl. v. *Michauxii* (Dode) Farwell); H20; Wenner 10; Goose B., D2, 3; KL.

Myrica Gale L.: H1, 4, 7, 8, *10*, *14*, 16, 18, 19, 27, 31, 34—38, 41—44; TW1; G3, 4, 7, 11; W18; D1, 12, Goose B,. KL,. Ash. 5, Mec.

Betula papyrifera Marsh. v. *cordifolia* (Regel) Fern.; H2, 4, 5, 7, 10, *16*, 18, 20, 21—*24*, 25, 34; G1, 4; D1, 7; Goose B., KL, Ash. 4, 5, Mec. — *B. papyrifera* v. *commutata* is probably absent from the area, see, however, Dutilly & Lepage 1962, p. 316.

B. borealis Spach.: (*B. microphylla* Bunge); D8, 12; W7, 17, 18, KL.

B. minor (Tuckerm.) Fern.: H*16*, *18*, *21*, (field-notes incl. *B. borealis* from H1, 5, 10 11, 22, 24, 25, 31, 32, 34, 35, 37, 44—47, 49, 51); Goose B. (H), KL, Ash. 1, 5, Mec.

B. glandulosa Michx.: H3, 4, 7, 10, 16, 18, 22, 24, 26, 27, 29—32, 34, 37, 41—45, 47—51; G2, 3, 5, 6; W1, 18; D1, 2, 12, 18; Mly Mt., Goose B., KL, Ash. 1, 3, 5.

B. pumila L.: Goose (B.); G4; KL (= *B. pumila* cf. v. *renifolia* Fern.); B. cfr. *pumila* from H26 and H34).

B. Michauxii Spach.: Goose B. (B); D12; KL, Ash. 3. Cf. Raymond and Rousseau 1950.

(*Corylus cornuta* Marsh.: Reported by Blake 1953, p. 101 as growing N of Goose River in birchwood?)

Alnus crispa (Ait.) Pursh (incl. v. *mollis* Fern.): H2—4, 14, 15, *18*, *21*, 27, 34, 35, 37, 41, 42, *44*—47, 49—*51;* G1—4, 8, 9, 12, 13; W9, 15; D1, 2, 12; Goose B., Attik., KL, Mec.

A. rugosa (DuRoi) Spreng. v. *americana* (Regel) Fern.: H*15* (earlier noted in Sandwich B. by Bishop 1930, p. 62), *27;* Goose B. (B); Ash. 3, 5.

Geocaulon lividum (Richards.) Fern.: H2, 4, 10, 12, 15—18, 25, 31, 34, 35, 41, 42, 44; G6; W6, 9; Goose B., Mly Mt., D1, KL, Ash. 5, Mec.

Urtica dioica L. ssp. *gracilis* (Ait.) Sel.: KL (H 1951, p. 209).

Oxyria digyna L.: H42, 49, *50*, 51; G13; KL (Viereck).

Rumex mexicanus Meisn. (*R. triangulivalvis* (Dans.) Rech. f.): H16, *21* (*R.salicifolius* Wein. of Hustich-Pettersson 1945, p. 43).

R. fenestratus Greene (*R. occidentalis* S.Wats.): H30, 34 (and several uncertain field-notes along the coast); W8, 12.

R. Acetosella L.; H*10*, 20, 47; W10; D1; KL (Viereck).

R. Acetosa L.: H10, 20.

Polygonum Fowleri Robins.:H*10* (det. A.E.P.); Rigolet (Löve et. al. 1956, p. 509).

P. boreale (Lge) Sm.: G4 (Gardner 1946, p. 18). Introd.?

P. aviculare L. s.l.: H10, 12, 20, 21, 34, 40, 41, 44, 47; G6; W10. Partly introd., partly perhaps v. *littorale* (Link.) W.D.J.Koch (= *P. buxiforme* Sm., see Löve et. al. 1956, p. 515)?

P. viviparum L.: H1, 4, 7, 16, 22, 24, 25, 29—31, 33, 34, 38—44, 47—49, 51; G2—4, 12, 13; W5—8, 20; D18, 19; Attik., KL.

P. convolvolus L.: H10.

Chenopodium album L.: H20, 34, 36; W9.

Atriplex longipes Drej.: H2, *10*, (det. I. Hiit.).

Montia lamprosperma Cham.: H1, 4, *8*, 10, *25*, *31*, 38—*41*, *44*, 47, 48.

Koenigia islandica L.: Gready Island (Abbe 1936, p. 148); Porsild, map 128 (three loc. N of Hopedale). Also reported by Tanner from the coast, but specimen lost.

Sagina caespitosa (J.Vahl) Lge.: H*51* (det. B.P. and E.H.).

S. procumbens L.: H1, 4, *6*, *31*, 34, *39*, *40*, *42*, *50*.

S. intermedia Fenzl.: Kaumajet (= *S. nivalis* (Lindbl.) Fr.: Abbe 1936, p. 150).

S. Linnaei Presl.: H*34*, *38;* TW9 (det. A.E.P.); KL (Viereck).

S. nodosa (L.) Fenzl.: D18 (Abbe 1955, p. 36).

Arenaria lateriflora L.: H*20;* W9.

A. macrophylla Hook.:Hopedale (Nat. Mus. Can.); Attik. (Harper), KL (H 1951, p. 209).

A. humifusa Wbg.: H*44*, *51;* KL.

A. peploides L.: H*10*, 12—14, 15, 19, 25, 31, 34, 41, 46, 47; G6, 12; W5—7; Goose B.(B.).

A. groenlandica (Retz.) Spreng.: H*10*, 16, *23*, 24, 27, 31, 34, 35, 38, 42, 44, 47, 49, 51; TW8; G12; W17; Mly Mt., Attik., KL.

A. rubella Wbg.: H*42*, *47*,*50;* Abbe 30, 50; TW9.

A. sajanensis Willd.: H*47*, *49*—*51;* TW9; KL.

A. uliginosa Schleich.: KL (H 1951, p. 209). Cf. Porsild, map 150.

Stellaria media (L.) Cyrillo: H1, *10*, 20, 27, 34, 36, 40, 41, 44, 47; G4; W8.

S. longipes Goldie s.l.: H1, 6, 7, *10*, 13, *15*, *16*, 17, *19*—*21*, 26, *31*, 34, 38, 40—44, *47*, *51;* TW9; G4; W1, 5, 6 (= v. *laeta* (Richards.) Wats.); KL.

S. monantha Hult.: H*16*, *31*, *50* (det. A.E.P.); KL (?), cf. Porsild, map. 133— Re. *S. crassipes* Hult., cf. Porsild, map 132 (three loc. in S.Labrador) and Hultén, map 7.

S. calycantha (Ledeb.) Bong.: H*22*, 26, *31*, 34, 38, 40, 44, *47*, *50*, *51;* G12; W9; Attik., KL.

S. longifolia Muhl.: Goose B. (Porsild 1944, p. 5).

S. humifusa Rottb.: H4, 13, *19*, *30*, *31*, 34, *39—42*, *47*, 51; G4; W8.

S. crassifolia Ehrh.: H20, *34;* W9.

Cerastium alpinum L.s.l. (see Hultén 1956, p. 427 f.): H1, 7, 10, 19, 22, 24, 25, 30, 31, 33, 34, 41—43, 47—49, *50* (v. *glandulifera* Koch), 51; TW5, 9; G2, 4, 5, 12, 13; W1 (v. *lanatum* Hegetschw.); KL (v. *glandulifera*).

C. arcticum v. *vestitum* Hult.: KL (see Hultén 1956, p. 456) — *C.* cfr. *arcticum* Lange: H*31*, *42*, *50* (det. J.J.).

C. Beeringianum C. & S.: TW3 (det. A.E.P.). See Hultén (1956, p. 482) re *C. Beeringianum* ssp. *terrae-novae* Hult. from Indian Hr.

C. arvense L.: TW5, 7; G13; W1; KL. — *C.* cfr. *arvense:* H*24*, *31* (det. J.J.).

C. cerastoides (L.) Britt. (= *C. trigynum* Vill.): H29, *38* (det. B.P.), *51* (det. J.J.).

C. cfr. *caespitosum* L.: H*10* (det. J.J.).

Melandrium affine (J.Vahl) Hartm.: Porsild, map 154 (one loc., Okak?).

Lychnis alpina L. v. *americana* Fern.: H7, 9, 47—51; TW3, 9; G4, 12, 13; D8.

Silene acaulis L. v. *exscapa* (All.) DC.: H1, 3, 4, 7, 8, *30*—33, 39—42, 48, 49, 51; TW3; G2, 4, 5, 12, 13; W1; Mly Mt.

S. cucubalus Wibel: H*34*, 49 (acc. to Tanner 1944, p. 382).

Nuphar variegatum Engelm.: H2; G4 (»Cape North»); D6; KL, Mec.

Ranunculus trichophyllus Chaix. (ind. v. *eradicatus* (Laest.) Drew): H*30;* D2, 13, 19; KL, Ash. 3.

R. Cymbalaria Pursh: H4, 8, 13, *19*, 30, 39, 40; G3, 4; cfr Porsild, map 168.

R. hyperboreus Rottb.: H*44*, 51; W1.

R. lapponicus L.: H*15*, 21; TW7; W5; D4; Attik., KL.

R. reptans L.: H1, *30*, *31;* G4; W11; D2. Ash. 3.

R. pygmaeus Wbg.: H*38*, *47*, 49—*51*.

R. nivalis L.: Porsild, map 169 (one loc., Hebron?)

R. pedatifidus Sm. (v. *leiocarpus* (Traut.) Fern.: G13; Abbe 50; KL.

R. Pallasii Schlecht.: Porsild, map 164 (one loc., Hopedale?).

R. Allenii Robins.: H*50*, *51;* TW4; G13; KL.

R. abortivus L. v. *acrolasius* Fern.: D18 (Abbe 1955, p. 36).

R. pensylvanicus L. f.: W11 (Wetmore 1923, p. 8).

R. acris L.: H20; G4; W19.

Thalictrum polyganum Muhl.: H*2;* W19; D3; Ash. 3 (Harper 1958, p. 19).

T. alpinum L.: Hultén, map 220 (one loc. Okak?).

Anemone parviflora Michx.: H49—*51;* TW4; G13; Attik., KL.

Coptis groenlandica (Oeder) Fern.:H2, 4, *20*, 21, 25, 28, 31, 34, 36, 41, 42, 44, 47, 49; G3, 4, 6; W4, 9; D2, 18; Mly Mt.; KL, Ash. 4, Mec.

Actaea rubra (Ait.) Willd.: W12; D12; KL (incl. f. *neglecta* = *A. alba* Mack. & Rydb.).

Papaver radicatum Rottb.: H*50*, *51;* TW7, 9; G12. Cf. Porsild, map 175.

Corydalis sempervirens (L.) Pers.: D7; KL. Also noted by Tanner 1939 from the Grand Lake area.

Draba Allenii Fern.:H*51* (det.A.E.P.), cf. Hultén, map 208.

D. nivalis Lilj. (incl. v. *hebecarpa* Lindbl.): H*42*, *49*, *50*, *51* (det. A.E.P.); Abbe 30; KL.

D. incana L. (incl. v. *confusa* (Ehrh.) Lilj.): H1, *10*, *16*, *19*, 30, 41, 42, 44, 47; G3.

D. lanceolata Royle:H*30* (det.A.E.P.).

Not noted before from the area (Böcher 1952, p. 28).

D. rupestris R.Br. (= *D. norvegica* Gunn.): *31, 51;* Abbe 50; KL (Viereck).

D. arabisans Michx.: H*47*, 49, *50* (det. B.P. and A.E.P.).

D. glabella Pursh: H*49, 50* (det .A.E. P.); G4; KL.

D. aurea M.Vahl: H*50* (det. B.P.).

D. lactea Adams: H*49, 50, 51;* (det. A.E.P.).

D. crassifolia Graham: H*50, 51* (det. B.P.).

Lesquerella arctica (Wormskj.) Wats.: Nain (Hettasch' coll.), cf. Porsild, map 183.

Thlaspi arvense L.: H20, 34; W19.

Subularia aquatica L.: H2, *30;* KL; cf. Hultén, map 197.

Capsella bursa-pastoris (L.) Medic.: H1, 10, 20, 44, 47; G4; W5.

Cochlearia officinalis L.: H*30, 31*, 32, *34, 39, 42;* TW1; G2—5. — *C. officinalis* ssp. *arctica* Fr.: H*6, 22* (det. A.E.P.).

Brassica hirta Moench.: H*20*.

Raphanus raphanistrum L.: G4 (Gardner 1946, p. 21).

Sisymbrium Hartwegianum Fourn.: H20 (det. B.P.; *Descurainia Richardsonii* (Sweet.) O.E. Schulz (?), see Abbe 1955, p. 37).

Rorippa islandica (Oeder) Borbas v. *Fernaldiana* Butt. & Abbe: H10; G4; Sandwich B.(Bishop 1930, p. 62; D1, 12; KL.

Barbaraea cfr. *vulgaris* R.Br.: KL (Vogelmann in letter).

B. orthoceras Ledeb.: Attik. (Harper). See Fernald 1950, p. 717.

Cardamine bellidifolia L.: H47, *50, 51;* TW9; KL (Viereck 1957, p. 48).

C. pratensis L. coll.: H*30* (sterile); Kl. (sterile). — *C. pratensis* v. *angustifolia* Hook.: Attik. (Harper 1958, p. 81).

Arabis alpina L.: H34, 42, *47, 50, 51;* TW4, 9; G12, 13; D18; Attik., KL.

A. Drummondii Gray: H*21* (det. B.P.).

A. arenicola (Richards) Gelert: H*50;* TW8.

Sarracenia purpuraea L.:Goose B.(B): W16; D12; Ash. 3, Mec.

Drosera longifolia L. (= *D. intermedia* Hayne): H*37;* cf. Hultén, map 38.

D. anglica Huds.: D12 (Abbe 1955, p. 37).

D. rotundifolia L.: H2—4, 7, 10, *16*, 17, 27, 34, 36, *37*, 38; G3; D12; KL, Ash. 4, Mec.

Sedum Roseum (L.) Scop.: H1, 3, 4, 7, 8, 10, *12*—19, 21, 22, 26, 28, 30—35, 38—44, 47—49, 51; G2—7, 12.

Saxifraga stellaris L.: H*6*, *29*, 38; TW9, G12, Cf. Porsild, map 219 and Hultén, map 91.

S. foliolosa R.Br. (= *S. stellaris* v. *comosa* Poir.): H*49* (det. B.P.).

S. rivularis L.: H1, 3, 8, 13, *30*—32, 39—*42*—44, 48, *49*—*51;* TW9.

S. nivalis L.: H*30*, 34, 39, 41, *42, 49—51*. Cf. Porsild, map 216.

S. cernua L.: H*42*, 49, *50, 51;* TW9.

S. Hirculus L.: Port Manvers, acc. to Delabarre 1902, p. 181, see, however, Porsild, map 215.

S. cespitosa L.: H1, *30, 31*, 33, 42, *43, 50*, 51; TW9; G4.

S. tricuspidata Rottb.: Porsild, map 221 (one loc., Domino Isl.?).

S. aizoides L.: TW9 (Wenner 1949, p. 53); G13; D18.

S. Aizoon Jacq.: H*42, 49, 50;* TW9; G13; KL.

S. oppositifolia L.: H1, *30, 31*, 42, 49, *50*, 51.

Mitella nuda L.: Goose B.(B.); D10; Attik., KL, Ash. 2.

Chrysosplenium tetrandum (Lund)

Fries: Porsild, map 222 (one loc., Hopedale?).

Parnassia Kotzebuei Cham. & Schlecht.: H*50*, *51;* TW9; G13; Attik., KL.

P. parviflora DC.: G4, 13; D18.

P. palustris L. v. *neogaea* Fern.: H12, 18, *30*, 34, *41*, *42*, 47, 49, 51; TW1, 4; W1, 16; D18; Attik., KL, Mec.

P. caroliana Michx. (= *P. glauca* Raf.): G4 (Gardner 1946, p. 20).

Ribes lacustre (Pers.) Poir.: D2 (Abbe 1955, p. 38).

R. glandulosum Grauer.: H*10*, *14*, *46* (and uncertain field-notes from sev. loc. along the coast); G1, 4, 9; W(fq.): D1, 2, 10, KL, Mec.

R. triste Pall. v. *albinervium* (Michx.) Fern.: KL (H 1951, p. 11).

R. americanum Mill.: Goose B. (Blake 1953, p. 101).

Sorbus decora (Sarg.) v. *groenlandica* (Schneid) Jones (partly incl. *S. americana?*): 2—5, 10, 15, *16*, 18, 20, 22, 24, 31, 36, 38, 41, 42; G1, 4, 6, 9; W17, 18; Goose B. (B); D2, 18; KL.

Amelanchier Bartramiana (Tausch.) Roemer: H2—5, *10*, 16, 34—36, 38, 44; G1; W6; D4, 10; Mly Mt., KL, Ash. 3, Mec.

Sibbaldia procumbens L.: H*29*, *31*, 44, 47, 49, *50*, *51;* Mly Mt., KL.

Potentilla fruticosa L.: Goose B. (Porsild 1944, p. 15); Ash. 2. Also coll. by Tanner 1939 in the Grand Lake area.

P. tridentata Ait.: H1—5, 7, 8, *10*, 11, 16, 17, 20, 22—27, 31—35, 38, 41, 42, 44, 45, 48; TW8; G2, 4, 7, 8, 12; W6; D2, 3; KL.

P. palustris (L.) Scop.: H1, 4, 7, 8, 10, 16, 18, 21, 25, 31, 34, 41; G1, 4, 6, 8; W5; 6, 8; D2, 10; KL, Ash. 3, Mec.

P. nivea L. s.l.: H42, 50, 51; G7, 12; KL (*P. nivea* ssp. *Chamissonis* (Hult.) Hiit., acc. to I. Hiit.).

P. norvegica L. v. *labradorica* (Lehm.) Fern.: H*10*, 16, 18—20, 25, 27, 41, 42, 44, 45, 47; Goose B. (B); W5—10, 16, 19, 20; Attik., KL.— *P. norvegica* v. *hirsuta* (Michx.) Lehm.: G4, Ash. 5, (H 1951, p. 173).

P. hyparctica Malte v. *elatior* (Abrom.) Fern.: G13 (Gardner 1946, p. 24).

P. Crantzii (Cr.) G. Beck: H41, 44, 47, 49—*51*; Abbe 30, 50; TW9.

P. rubricaulis Lehm.: G12? Cf. Porsild, map 232.

P. Egedii Wormskj. (incl. v. *groenlandica* (Tratt.) Polunin): H*13*, *15;* G1, 4, 6; W1—9, 16—18, 20.

P. anserina L.: Wenner 31; TW7; G7.

Dryas integrifolia M. Vahl: H30, 31, 49—51; TW3, 5, 6; G13; W1; KL.

Geum macrophyllum Willd.: W15 (Wetmore 1923, p. 9).

G. rivale L.: Attik. (Harper), KL (H 1951, p. 212; also Viereck 1957, p. 61).

Rubus Chamaemorus L.: H1, 4, 8, 10, 11, *15*—17, 23—27, 31, 32, 35—45; 47—49, 51 (see Abbe 1936, p. 154)[1] G2—5; W1—9, 15—18, 20; Mly Mt. Goose B., D2, 12; Attik., KL, Ash. 3, 4, Mec.

R. pubescens Raf.: H*15*, 19, 21, *28*, 31, *34*, 35, 38, *42;* D2, 8; W9; G4; KL. Mec. (At loc. H34 and H42 *R.* cfr. *saxatilis?*). Cf. Boivin 1955, p. 236.

---

[1] Tanner (1944, p. 388) remarks that »the equisite aroma of the European berries »(of *R. arcticus*) is lacking. This, however, is probably a resulf of the different light conditions in Labrador and in Finland. The whole question about the *R. acaulis*—*R. arcticus* complex is not clear, cf. Boivin (1955, p. 235).

R. acaulis Michx. s.l.: H7, *10*, 16, *19*—*21*, 24, 25, 27, 28, 32, 35—37, 40, 42—44, 47, 49—*51;* TW7; G1, 4, 7, 11, 12 (»R. arcticus»); D18; Mly Mt., Attik., KL. Possibly incl. *R. arcticus* L.[1] (i.a. at loc. H*19*, acc. to I.Hiit.); cf. also Fernald 1950, p. 819.

R. idaeus L. v. *strigosus* Michx.: G4; Goose B.(B), Attik., KL —*R.idaeus* v. *canadensis* Richards.: D2 (Abbe 1955, p. 38). — *R. idaeus* s.l. from several loc. along the coast: H2, 10, 14, 16, 18—21, 38.

Fragaria virginiana Duchesne v. *terrae-novae* (Rydb.)Fern.:KL(H1951, p. 211);note Löve et al, 1958, p. 62).

Alchemilla filicaulis Buser: H*36* (det. G.M.); KL (H 1951, p. 212). cf. Hultén, map 96. — *A. vulgaris* L. coll. noted by Gardner (1946, p. 26) from G12, 13.

A. glomerulans Buser: H*38* (det.G.M.), cf. Hultén, map 95.

A. minor Huds. (= *A. vestita* (Buser) Raunk.): KL (Grayson), cf. Hultén, map 109.

Sanguisorba canadensis L.: H*10*, *34*, 37; G4; W10—12; Goose B.(B); D2, 12; Grand Lake (Tanner 1944, p. 384), KL (Viereck), Ash. 3, 4.

Prunus pensylvanica L. f.: H*20;* Goose B.; D2, 7; W9. Cf. Low 1895, p. 530.

Trifolium repens L.: H10, 20, 36; W19.

T. pratense L.: W19; KL (Vogelmann).

T. agrarium L.: W19 (Wetmore 1923, p. 8).

Astragalus eucosmos Robins.: H*42;* Abbe 30, 50. Cf. Porsild, map 241.

A. alpinus L. s.l.: H*30*, *31*, 47, 49, 51. Wenner 30 (ssp. *arcticus*); Abbe 50; TW5; G4, 5, 12; W1.

Oxytropis terrae-novae Fern.: H7, *8*, *26* (det. J.J.), 32—34, 41, 49, 51; Abbe 1, 30;TW5; G2—4, 12; W1(?);

O. johannesis Fern.: H*42*, *50* (det. J.J.).

O. podocarpa Gray.: Porsild, map 245 (two loc., Nain and Hebron?).

O. monticola Gray. (= *O. campestris* L.): G2 (Gardner 1946, p. 27).

Vicia cracca L.: H10, 20, 27, 30, *31;* W19.

Lathyrus japonicus Willd. s.l.: H1, 3, 4, 7, 8, 10, 12—14, 16—*21*, 22, 24—26, 31, 33, 34, 38, 40, 41, 43, 47; G4, 6, 7; W(fq).

Oxalis montana Raf.: Mr. N. Drummond reports (in letter) the species from Romaine R. (51°n.lat.). At lower Hamilton R. in rich woods acc. to Mr. W.C.Wilton (in letter).

Geranium pratense L.: H20; W10 (specimen in Nat. Herb. of Canada); Goose B. (B).

Callitriche palustris L. (= *C. verna* L.): W12 (*C.* »cfr. *palustris*» from H13).

C. heterophylla Pursh: H*30* (det. B. P.); Nain (Nat. Mus. Can); KL.

C. anceps Ferm.: Okak (Nat. Mus. Can.), KL, Ask. 2 (Harper).

Empetrum nigrum L. coll.: Probably all *E. hermaphroditum* (Lge) Hagerup (cf. Hustich-Pettersson 1944) and *E. Eamesi* Fern. & Wieg. ssp. *hermaphroditum* D. Löve (Löve 1960): H1—4, *7*, 8, *10*, 11, 15—17, 22—*27*, 31, 32, 34—36, 38—49, 51; Wenner 16, 31; G2 —4, 7, 12; D1, 12; 18 Mly Mt.: W(fq); Attik., KL, Ash. 5, Mec. —*E. Eamesi:* Salmon Bight (A.E. Porsild). — *E. atropurpureum* Fern. & Wieg.: Wenison Tickle (Nat. Mus. Can.). Cf. Löve 1960.

Acer spicatum Lam.: D5 (Abbe 1955, p. 39); also reported by W.C.Wilton from lower Hamilton R. and by N. Drummond from Romaine R. (51° n.lat).

Viola cucullata Ait.: Mly Mt. (Gillette 1954, p. 121).

V. palustris L.: Hopedale (Abbe 1936, p. 156), Goose B. (Porsild 1944, p. 5). Cf. Hultén, map 103.

V. pallens (Banks) Brainerd.: H*15*, 16, 28, 35; G3, 4, 6; Goose B. (B); D2; KL, Ash. 4, Mec.

V. adunca Sm. v. *minor* (Hook.) Fern. (= *V. labradorica* Schrank): H31, *37*, *38*, *50*; TW7, 9; G5, 13; W1, 3; D18, 19; Attik., KL, Ash. 4, Mec.

V. Selkirkii Pursh.: S-Labrador, acc, to Böcher 1954, p. 67. Cf. Fernald 1950, p. 1038.

V. conspersa Reichenb.: H31 (det. A.E.P.), probably also at H38—39, and H51; Mly Mt.

Shepherdia canadensis (L.) Nutt.: Winter Hr. (Gardner 1946, p. 28).

Epilobium angustifolium L.: H1, 3, 4, 7, 8, 10, 13, 16—20, 25—27, 30, 31, 34, 38—41, 43, 45, 47, 49, 51; TW1; G3—7, 9; W(fq, west of W4); D8; KL, Ash. 3, 5, Mec.

E. latifolium L.: H7, 8, 27, *31*, 34—*36*, *38*, *14*—45, *47*, *50*, *51;* TW5, 6; G7, 11—13; W3, 9; D9, 10, 18; Attik., KL (Viereck).

E. palustre L. (incl. v. *labradoricum* Hausskn. and v. *longirameum* Fern & Wieg.): H*8*, 13, *21*, *25*, *30*, *31*, *34*—39, *43*, 44, 49; G4, 6, 8, 12; W8; Attik., KL, Ash. 5.

E. lactiflorum Hausskn.: H29, *34* (det. A.E.P.), 38, 43, 51; D12.

E. glandulosum Lehm. v. *adenocaulon* (Hausskn.) Fern.: H10, 34?; W8, 12, Goose B.(P); D7.

E. anagallidifolium Lam.: H*29*, 34, *38*, *42*, *43*, *50*, *51;*Mly Mt. D18, KL.

E. Hornemanni Reichenb.: H*42;* G4, 5, 12, 13; Attik., KL. Ash. 2.

Circaea alpina L.: D12 (Abbe 1955, p. 40).

Myriophyllum alterniflorum DC.:H28; KL, Ash. 5. Cf. Hultén, map 234.

Hippuris vulgaris L.: H4, 31, 37, 44, 51; TW1; G4, 7; D12; Attik., KL, Ash. 3, 5.

H. tetraphylla L.f.: W8 (Wetmore 1923, p. 10).

Aralia hispida Vent.: Goose B.(H); D3.

Ligusticum scothicum L.: H1, 3, 4, 6—10, 13, 31, *34*, 38—44; G4, 6.

Coelopleurum lucidum (L.) Fern.: G2, 4; W5, 6.

Conioselinum chinense (L.) BSP.: H1, *2*—4, 10, 30; G4.

Angelica atropurpurea L.: H1, 4, 9, 10, *14*, 16, 18, 19, *22*, 30, 31, 34, 35, 38, 43; G(Aillik); W1, 5, 6, 15.

Heracleum maximum Bartr.: H*20*; Goose B.(B.); D2; Attik., KL.

Cornus canadensis L.: H5, *10*, 15, 16, 18, 20, 21, 31, 41, 44; TW1, 5; G1, 2, 4; W4, 6, 9, 13; Mly Mt., D1, 18; Attik., KL, Ash. 1, 5, Mec.

C. suecica L.: H*10*, *14;* Wenner 30; G2—4, 7, 12; W1, 5, 6; KL (Grayson), Ash. 4 (?).

C. stolonifera Michx.: Goose B.(H); W14, 17; D2; KL, Ash. 3, 5.

Moneses uniflora (L.) Gray: H10, 16, 34, 36, 38, 41, 42, 46; D2, 9; Attik., KL, Ash. 3, 5.

Pyrola secunda L. (incl. v. *obtusata* Turcz.): H12, *19*, 34, 36, 38, 41; Abbe 50; G12; W14; D2, 3; KL, Ash. 3, 5, Mec.

P. minor L.: H*36*, probably also at H12, 34, 42; G12, 13; W15; Goose B.(B), D9, KL.

P. virens Schweigger: TW7 (det. A.E.P.); D3.

P. asarifolia Michx. (incl. v. *incarnata* (Fisch.)Fern.): D9; Attik., KL.

P. grandiflora Radius: H49—*51*; G7, 12; KL.

Monotropa uniflora L.: Goose B. (Blake 1953, p. 165).

Ledum groenlandicum Oeder.: H8, 10—12, *14*, *22*, 35, 38, 41—45, 47, 51; Wenner 31; Goose B., G1—6, 8, 12; (W(fq); D1, 18, Mly Mt., KL, Ash. 3, 5, Mec.

L. palustre v. *decumbens* (Ait.) Lodd.: uncertain field notes from several loc. (prostrate *L. groenlandicum* in some cases?); Abbe 5; G2, 4, 7, 13; W1.

Rhododendron lapponicum (L) Wbg: H*31*, *44*, *47*, 49, *51;* TW1, 4, 9; Mly Mt., KL (Grayson, Viereck).

Loiseleuria procumbens (L.) Desv.: H1, 3, 4, 6, 7, *10*, 11, 16, 23, 27, 31, 32, 34, 35, 38, 42—44, 46—47; TW5; G2; Mly Mt., KL.

Kalmia angustifolia L.: H*2;* D1, 12, 17; W9—15, 20; Goose B.(H).

K. polifolia L.: H2—4, 7, *10*, 14, 16, 17, *28*, 31, 32, 34—36, 38, 42—45, 47; G1—7; Goose B.; Attik., KL, Ash. 2, 3, 5, Mec.

Phyllodoce coerulea (L.) Bab.: H1, 4, 6, 7, 11, 12, 27, 28, 32, 34—36, 41—44, 46, 47, 49, 51; TW5, 9; G2—6, 9; W4; Mly Mt., KL, Ash. 1.

Andromeda glaucophylla Link.: H3, 4, 7, 10, 27, *37*, 38, *43*, *44*, 47; G2, 4; Goose B., D12; Mly Mt., KL, Ash. 2, 3, 5, Mec.

A. polifolia L. reported by Gardner 1946 from G2, 4. Common north of Nain (A. E. P. in letter).

Chamaedaphne calyculata(L.)Moench.: H2—4, *10*, 16, 17, 22—24, 27, *34*, 35, 38, *44*, 45, 47; W4, 6; D2, 12, 18; Goose B., KL, Ash. 5, Mec.

Cassiope hypnoides (L.) D.Don.: H*47*, 49, 51; G13; Mly. Mt, KL.

C. tetragona (L.) D.Don.: H*51;* KL-area (Vogelmann).

Gaultheria hispidula (L.) Bigel: H2, 10; W4; D1, 2, 17; Goose B.(B), KL, Ash. 3, 5; Mec.

Arctostaphylos alpina (L.) Spreng.: H1, 3, 4, 6, 7, *10*, 11, 16, 17, 22, 23, 26, 27, 31, 32, 34, 35, 38, 41—45, 47—49, 51; TW1; G3, 4, 7, 12; W4, 7, 17, 20; Mly Mt., KL, Ash. 1, 2.

A. uva-ursi (L.) Spreng. v. *adenotricha* Fern. & Macbr.: Ash. 5 (H1951, p. 213), — *A. uva-ursi* v. *coactilis* Fern. & Macbr.: Goose B.(Blake 1953, p. 165). Cf. Böcher 1954, p. 218.

Vaccinium uliginosum L. v. *alpinum* Bigel: H1—4, 7, 8, 10, 11, 13, 17, 22—28, 31, 34—35, 47—49, 51; TW1; G1—6, 9, 12; W(fq); D(fq); KL, Ash. 1, 3, 5, Mec.

V. angustifolium Ait.: H2—5, 7, *10*, 15, *16*, *20—23*, 27, 30, *34*, 36—38, 41, 42, 44, 49; G1, 12; D1, 12; KL (= v. *integrifolium* Lepage, acc. to Dutilly et al. 1957, p. 147), Ash. 3 (= v. *laevifolium* House), Mec.

V. myrtilloides Michx.: H*20*; W(fq?); Goose B. (Lepage); D2, 12; KL, Ash. 5.

V. cespitosum Michx.: H*5*, *36;* G1, 4; KL; Ash. 4.

V. Vitis-Idaea L. v. *minus* Lodd.: H1—4, 7, 8, 10, 11, 17, 22—27, 31, 34—45, 48—*50*, 51; TW5; W(fq); D1, 2; Goose B., Attik., KL, Ash. 3, Mec.

V. Oxycoccus L. (incl. *Oxycoccus quadripetalus* Gilib. v. *microphyllus* (Lge) Porsild and *O. microcarpus* Turcz.): H4, 8, *10*, 16, 17, 25, 27, 31, 32, 34, 35, 37, 41, 43; G4, 6; W4; Goose B., D2, 18; KL, Ash. 3, —5; Mec.

Diapensia lapponica L.: H1, 3—4, 6, 7, *10*, 11, 16, 22—24, 26, 27, 31, 34—35, 38, 41, 44, 45, 47—49, 51;

TW3, 5; G2—4; W17; Mly Mt., KL, Ash. 1.

Primula laurentiana Fern.: H1,4,*6*, *30*, 34, 39, 41, 42, 49; G4; W11; KL.

P. stricta Hornem.: H*50;* G2. Cf. Porsild, map 276.

P. egaliksensis Wormskj.: H*30*, 31, *34*, 37, 43, *50;* Attik.

P. mistassinica Michx.: Hamilton R., see Fernald 1928, p. 89; Ash. 2 (Harper).

Trientalis borealis Raf.: H1, 4, 7, 14, *15*, 16, 18, 19, 24, 31, 34—36, 38, 41—45, 49; G1, 3—6, 9; W(fq); D1; Mly Mt.; Attik., KL, Ash. 1, 5, Mec.

Armeria maritima (Mill) Willd. ssp. *labradorica* (Wallr.) Hult.: H*31*, 49, *50*, *51;* TW7; G12, 13; cf. Hultén, map 88.

Gentiana nivalis L.: H*51*; cf. Hultén, map 97.

G. Amarella L.: G12; W3; Cartwright (= ssp. *acuta* (Michx) Gill.), Gillett 1957, p. 255,

G. linearis Froel.: D12 (Abbe 1955, p. 42); Ash. 4 (Grayson 1956, p. 48).

Lomatogonium rotatum (L.) Fr.: H1, 4, 6—8, 12, 30, 31, 34, 37, 40, 42; TW1, 4, 9; G4.

Halenia deflexa (Sm.) Griseb.: H*7;* G4.

Menyanthes trifoliata L. v. *minor* Raf.: H10, 36, 37, *43*; D12, 18; G4, 7; Attik., KL, Ash. 4.

Mertensia maritima (L.) S.F.Gray: H1, *3*, 12, 13, 32, 34, 35, 38—41, 43; Wenner 30, 42; G2, 4, 7; W1, 3.

Lappula echinata Gilib.: H*34*.

Scutellaria epilobiifolia A.Ham.: D10 (Abbe 1955, p. 42).

Prunella vulgaris L. v. *lanceolata* (Bart.) Fern.: D12 (Abbe 1955, p. 42).

Galeopsis Tetrahit L.: H20; W18, 19.

Mentha arvensis L. v. *villosa* (Benth.) Stewart: W12; D12.

Limosella aquatica L.: H8, *13*, *27*. Cf. Hultén, map 187.

Veronica alpina L. v. *unalaschcensis* C. & S.: H*31*, *38*, 42, 44, 49, *50*, *51;* TW9; G5, 12, 13; Mly Mt., Attik., KL.

V. scutellata L.: Tikkoatokak (Bishop 1930, p. 62);D12 (Abbe 1955, p. 42); KL.

Castilleja septentrionalis Lindl.: H34, 36—38, 40—*42*, 44, 49, 51; TW5, 6, 9; G12, 13; W11; D12; Mly Mt., Attik., KL, Ash. 3.

Euphrasia Oakesii Wettst.: H*6*, *39* (det. B.P. and A.E.P.).

E. Randii Robins.: H*31* (det. E.H.).

E. arctica Lge.: H*30*, *31*, *41*, *50;* (det. E.H.); W1, 2; TW9 (= *E. frigida* Pugsl., det. A.E.P.).

E. disjuncta Fern & Wieg.: H*34*, *37* (det. E.H.); G12.

Bartsia alpina L.: H49, *50*, 51; Abbe 30; TW9; G12, 13; KL.

Rhinanthus groenlandicus Chab. (= *R. borealis* (Sterneck) Chab.): H*13*, *19*, *42*, 44; TW9; G4; Attik., KL.

R. Crista-Galli L.: Wenner 16; G4; W1.

Pedicularis flammea L.: H*30*, 31, *43*, *47*, *49*—*51;* TW5; W1; KL (Grayson, Viereck).

P. hirsuta L.: Port Manvers (Nat. Mus. Can.).

P. lapponica L.: H49, *50;* TW4; G12, 13.

P. palustris L.: G9 (Gardner 1946, p. 34). Cf., however, Hultén, map 141.

P. euphrasioides Stephen (= *P. labradorica* Wirsing): H*17*, 26, 27, *30*, 35, *38*—*44*, 46, *47*, *49*—*51*; TW5, 6; G3, 5, 6, 12; W1, 6; Mly Mt., KL.

P. groenlandica Retz.: H*34*, 38, *49*;

TW7; G12; W11, Mly Mt., Attik., KL.

Utricularia vulgaris L: H*27* (sterile); D11, 12; Ash. 3 (Harper). Note also Löve et al. 1958, p. 65.

U. minor L.: H*2*, *27*, *37* (sterile); KL.

U. cornuta Michx.: Goose B. (Blake 1953, p. 165).

Pinguicula villosa L.: H*31*, 32, 46, 51; Abbe 30; W1.

P. vulgaris L.: H1, 4, 7, *31*, 34, 35, 37, 38, 41, 43, 44, 47, 49, 51; TW5; G2—4, 11; W1; Mly Mt.; D20; Attik., KL. — (*P. alpina* reported from Hopedale by Delabarre 1902, p. 188, an error, cf. Hultén 1958, p. 15).

Plantago juncoides Lam. v. *decipiens* (Barn.) Fern.: H1, 3, 4, 7, 8, *12*, *14*, 16, 18, 19, 22, *23*, *25*, *30*, 31, 33, 34, 39—41, 44; TW3; G1, 4, 7; W20.

P. major L.: G8 (Gardner 1946, p. 35).

Littorella americana Fern.: Mec. (det. M.R.).

Galium triflorum Michx.: W15; Goose B.(B); D18; KL.

G. palustre L.: Hultén, map 151 (two loc. at Hamilton Inlet).

G. Brandegei Gray: Attik., Ash. 2, 3 (Harper).

G. trifidum L.: H8, 13, 18, *25*, *39;* W10; D10.

G. labradoricum Wieg.: H*35;* W10; KL.

Lonicera villosa (Michx.) R. & S.: H*10;* Abbe 30; G4, 6; Ham. i Hon Inlet (v. *calvescens* Fern., Abbe 1955, p. 43); Mly Mt., KL, Ash. 2.

(*L. oblongifolia* (Goldie) Hook.: reported by Löve et al. 1958, p. 65 W of Ashuanipi).

Lobelia Dortmanna L.: H*2;* Mec. Cf. Hultén, map 192.

Linnea borealis L. v. *americana* (Forbes) Rehd.: H1, 7, *12*, 16, 18, 20, 31, *34*, 36, 38, 40—44; G1, 4, 6, 12; Goose B.; D1; W(fq); KL, Ash. 3, 5, Mec.

Viburnum edule (Michx.) Raf.: H3, 4, *15*, 16, 21, 25, 28, 34—36, 38, 39, 41, 42; Harrison (Wenner); G4; W9; Goose B., D2; Mly Mt., KL, Ash. 3, 5.

Campanula rotundifolia L. coll.: H3, *50*, *51;* Abbe 30; TW8; G12, 13.

C. uniflora L.: H*42*, *49*—*51;* Abbe 30.

Solidago multiradiata Ait.: H2—4, 5, 10, 15, *16*, 18, 20, 22, 24, 31, 36, 38, 41, 42; TW5, 9; G7, 12, 13; D9; Attik., KL, Mec.

S. Purshii Porter: D12; Ash. 2, 4.

S. lepida DC.: W15; Goose B. (B).

S. humilis Banks v. *abbei* Boivin: Goose B., acc. to Boivin 1962, p. 73.

S. macrophylla Pursh. (incl. v. *thyrsoidea* (Mey.) Fern.): H1, 4, 7, 10, 34—36, 38, 40—42, 44; TW6; G4, 5, 8, 9, 12, 13; W3, 9, 17; D12; Mly Mt., Attik., KL, Ash. 5.

Aster macrophyllus L.: Goose B. (Blake 1953, p. 166).

A. puniceus L. s.l.: H9, 10, 34, 42; Goose B.(B); D12 (= v. *laevicaulis* Gray); KL, Ash. 2 (= v. *oligocephalus* Fern.), 4.

A. foliaceus Lindl. s.l.: H10; G6; W11; Makkovik (= v. *frondeus* Bishop 1930, p. 62), Goose B. (B), KL.

A. radula Ait.(incl. v. *strictus* (Pursh.) Gray): H*34;* Goose B. (B), D12, KL, Ash. 2—4.

A. novi-belgii L.: G4 (Gardner 1946, p. 36); Goose B. (Dutilly et al.)?

A. nemoralis Ait.: H*2* (det. B.P.).

Antennaria labradorica Nutt. (= *A. Ekmaniana* Porsild): H*49*—*51* (det. B.P. and A.E.P.).

A. canescens (Lge) Malte: H*31*, *42*, *47*, *49*—*51* (det. B.P. and A.E.P.).

A. canadensis Greene: G2 (Gardner 1946, p. 36).

A. hudsonica Malte (= *A. angustata* Greene): H*50*, *51* (det. B.P.).

A. Rousseaui Porsild: see Porsild 1949, p. 80—81. — *A. isolepis* Greene: G12, 13 (Gardner 1946, p. 37);Cape Harrigan (Bishop 1930, p. 62); probably all *A. Rousseaui* acc to A. E. P.

A. pygmaea Fern: H49, 50 (det. B.P.); KL.

A. ungavensis (Fern.) Malte: KL (H 1951, p. 215).

A. petaloidea Fern.: G2 (Gardner 1947, p. 37).

Anaphalis margaritacea (L.) C.B. Clarke: W14; D7.

Erigeron unalaschkense (DC.) Vierh.: H49—*51;* TW4, 9; G13.

E. angulosus Gaudin v. *kamtschaticus* (DC) Hara: W19 (introd.?).

Gnaphalium supinum L.: H29, *31*, 35, *38*, 44, 47, 49; KL.

G. norvegicum Gunn.: G13; KL (Viereck). Cf. Hultén, map 29.

G. uliginosum L.: G4 (Gardner 1946, p. 37).

Achillea millefolium L. coll.: H4, 10, 18—20, *21*, 22, 24, 25, 34, 37, 41, 43, 44; G4, 6; W(fq); D2; Attik., KL.Mostly probably native *A. millefolium* v. *nigrescens* E.Mey. (= *A. borealis* Bong.), but partly introduced.

A. lanulosa Nutt.: KL (Grayson 1956, p. 112), probably also at H*6*.

A. Ptarmica L.: H1.

Chrysanthemum leucanthemum L.: Goose B.(B); W19 (v. *pinnatifidum* L. & L).

Artemisia canadensis Michx.: TW7; W13.

A. borealis Pall.: H*47;* TW7, 8; G12; D3.

Petasites palmatus (Ait.) Gray: H15, 34, 35; W12; Goose B.; D18; Attik., KL, Ash. 2, 5.

P. vitifolius Greene: D20; KL.

P. sagittatus (Banks) Gray: KL (H 1951 p. 215).

Arnica plantaginea Pursh: G12; Hamilton Inlet (Abbe 1936, p. 160).

A. alpina (L.) Olin ssp. *Sornborgeri* (Fern.) Maguire: H45, 49, *50*, *51*; TW4; KL. (H 1951, p. 215; ssp. *angustifolia* (J.Vahl) Maguire; also Viereck 1957, p. 54); cf., however, Hultén, map 203.

Senecio vulgaris L.: H1, 10, 40, *44;* G4.

S. congestus (R.Br.) DC. v. *palustris* (L.) Fern.: H*30*, 31; TW1; Abbe 1; W1; cf. Porsild, map 325.

S. Pseudo-Arnica Less.: H4, 7, 10, 12, 13, 16—19, 21, 22, 25, 30, 31, *34*, 35, 42; TW1, 4; G4, 9; W5, 6, 20.

S. pauperculus Michx.: KL, Ash. 2 (Harper).

S. discoideus (Hook.) Britt.: H*51;* TW4 KL (Vogelmann).

S. aureus L. v. *semicordatus* (Mack. & Bush) Greene: KL (Viereck 1957, p. 75).

S. pauciflorus Pursh: G12, 13; Abbe 50; KL.

Cirsium muticum Michx.: W15 (Wetmore 1923, p. 11).

Matricaria matricarioides (Less.) Porter: H1, 4, 10, 44, *47*.

M. inodora L.: G4 (Gardner 1946, p. 37).

Leontodon autumnalis L.: W19 (Wetmore 1923, p. 11).

Crepis nana Richards.: Kaumajet Mts. (Abbe 1936, p. 161).

Taraxacum officinale L. coll.: H*10*, 16, 20 (the specimens from H*10* close to *T. expallidum* Dt., but probably a new species, acc. to Dr. G. Haglund, in letter); W10.

T. croceum Dt. (= *T. lapponicum* Kihlm.): H8, *31*, 33, *35*, 38, 42, *43*, *44*, 49, 51; (det. G.H.); TW7, 9; G4, 5, 13; D18; Attik., KL, Mec.(?). Cf. Hultén, map 16.

T. lacerum Greene: TW5 (det. A.E.P.); G12; Abbe 44. Cf. Porsild, map 327. — *T. ceratophorum* (Ledeb.) DC.: W1 (Wetmore 1923, p. 11).

Hieracium canadensis Michx.: Goose B.(Blake 1953, p. 166).

H. groenlandicum Arv.-Touv.: H5, 7(?); G4, 13; KL. Fords Hr, September Hr, Okak (Nat. Mus. Can.).

Lactuca biennis (Moench). Fern.: W15 (Wetmore 1923, p. 12).

III. COMMENTS ON THE FLORA

The list of vascular plants in Chapter II contains a multitude of different plants, with different affinities, distribution and ecological requirements. This is not surprising, because our area comprises oceanic as well as arctic and subarctic habitats, an ocean coast and a vast taiga, the interior forest land. In many ways the boreal and subarctic part of eastern central Labrador resembles parts of Scandinavia and Finland as they were before man created so many new habitats and changed the structure of the forest.

Very few species are endemic in the Labrador area. The reason is that this area is rather young; it is only 15,000—10,000 (?) years since the Ungava-Labrador Peninsula was free from its ice-cap in glacial time. Another reason is the general stability of the habitats compared with, for instance, the James Bay west coast. The only species in the area that have their only localities (?) on the American continent along the Labrador coast are: *Alchemilla glomerulans* and *Gentiana nivalis*.

It is natural that along the Labrador coast with the cold stream flowing southwards down the coast, the coastal plants of southern origin do not extend very far north. It is striking that, according to Faegri's recent maps of 160 »oceanic» species (1960), the only plant occurring both on the Norwegian and on the Labrador coasts (the latter is situated about 10 latitude degrees further south) is *Myrica Gale*.

Many plants are very rare in the area, noted occasionally in particular habitats only, such as on gravel rich in lime or on some other habitats which occur as small »islands» in the generally rather homogeneous area. Often rare species, however, as is well known, catch the eye of the collector and thus may be overrepresented in the collections and in the literature. In other cases species are perhaps wrongly marked »rare» because the estimation is based only on

collected specimens.[1] Such species include, among others the freshwater plants (*Utricularia* ssp., *Potamogeton* ssp., etc.). Here the reason is purely lack of investigation. (»Botanists seem to avoid wet feet» as one of my collegues once put it.) This also appears clearly in my list of aquatic plants in Chapter II above and yet several of these localities are »new» for large parts of the area when compared with earlier distribution maps.

Many maritime localities and some alpine localities are, of course, grossly overemphasized in the inventory above, simple because the collecting has been more intensive on the quite recently more accessible coast than in the interior.

It is remarkable how few of the species in Chapter II are really *common* species. In fact, taking into account the area occupied by the different species it is almost certain that only about 50 species could be marked as more or less »frequent» (*st fq—fqq*), and these species cover over 95 per cent of the area where higher plants grow. It is from a phytosociologic point of view important that particularly these common species should be properly studied regarding their ecology. They form the »cells» which build up the vegetation. The ecological response and behaviour of the common plants regulates the dynamics of the vegetation cover. The »rare» plants are often only ornaments in the present-day vegetation.

For many genera we have numerous socalled »microspecies», which are difficult for an ecologist or an ordinary botanist; they are often also difficult even for a skilled specialist to determine (*Salix, Carex, Poa, Draba, Cerastium, Alchemilla, Euphrasia, Antennaria, Taraxacum*, etc.). But as the diversity of the flora is in itself a phytogeographical factor or indicator, also such species must be included in the flora. (The numbers of microspecies, variants or subspecies of a species is perhaps often comparable to the interest shown by taxonomists in the species or species complex in question.)

One striking feature — it may, however, be an illusion — appears when Chapter II is examined: the »*common*», and thus also important, *plants in the vegetation seem to be taxonomically rather clear-cut.* Many factors contribute to such a result. A large population of a species tends in general to have a greater stability. Large populations of a species point, on the one hand, to the fact that the species is an old one, but on the other hand, large populations of one and the same species also arise when habitats which are ecologically similar over wide areas, such as bogs, fens, old forests, etc., have remained undisturbed (as often is the case in the Subarctic).

*

[1] If judged only from their representation in herbaria, *Picea glauca* and other conifers, for instance, would be labelled *raro* or *rarissime*.

The alpine-arctic element comprises a large group mainly because inside this flora there are a number of small populous taxa, such as species of *Draba, Antennaria, Cerastium, Ranunculus,* etc. They generally play an unimportant role in the vegetation in our area as a whole, but on special habitats, such as snow-flush areas, treeless skerries, dolomite cliffs, etc., the arctic-alpine plants extend their range considerably towards the south along the Labrador coast, showing that the micro-climate in certain habitats is certainly colder than the isotherms indicate. 64 of the arctic-alpine species have not been found south of Hamilton Inlet. North of the entrance to Lake Melville, for instance, the snow-flushes at Cape St. Giles and the dolomite and anthrosite gravel patches near Indian Harbour (Smokey Island) afford some suitable habitats for northern plants. 42 of the arctic-alpine plants listed above have not been found south of the Nutak-Okak area, where there are already rather high mountains with proper arctic and alpine conditions. The Kaumajet Mts. already represent typical arctic habitats with a flora (compare ABBE 1936 and HUSTICH & PETTERSSON 1944—45), which is not much different from the flora on Torngat Mts. north of Hebron.

The boreal and subarctic part of eastern central Labrador has a rather poor flora. To give an idea of the number of species in the flora of various regions in Boreal, Subarctic and Arctic, I have below compared some recent floristic studies with Table I:

The Clay Belt (BALDWIN 1958)	856	species
Eastern coast of James Bay (DUTILLY et al. 1958)	747	»
Subarctic Hudson Bay Lowland (HUSTICH 1957)	735	»
Western part of James Bay area (DUTILLY, et al. 1954)	722	»
North shore of St. Lawrence (ST. JOHN 1922)	622	»
Eastern central Labrador, see map 3	612	»
Greenland (JØRGENSEN, et al. 1958)	437	»
Canadian Arctic Archipelago (PORSILD 1957)	340	»
Eastern Canadian Arctic (POLUNIN 1940)	297	»

It must be remembered that the numbers above are not entirely comparable to each other, because some authors include microspecies, others not. The differences between the areas mentioned above are, however, clear enough, and point out the intermediate position of our area regarding the richness of its flora. As my inventory is a very preliminary one, further research might add about 50 species to the list in Chapter II, cf. MACOUN'S list of plants in the upper Hamilton area (1895), cf. p. 9 above.

*

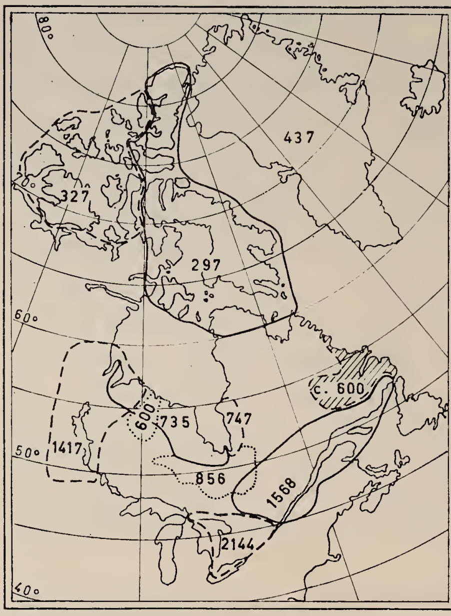


Fig. 3. Comparison of different regions re. number of species. Cf. p. 33 and BALDWIN 1958, p. 296.

Often the *introduced* or *anthropochorous* species are omitted from the lists of plants, as something secondary. To-day this omission is inadvisable, because from year to year the quantitative importance of the introduced species in the vegetation increases. We can superficially observe this fact when we compare, for instance, the flora of our Labrador area with the present-day flora of Finland. It can be assumed that many centuries ago the flora and vegetation of Finland looked much the same as the flora and vegetation in Labrador today, before man had to a greater degree changed the structure of the forest and the pattern of the landscape, by introducing weeds and plants which have successfully invaded the new habitats created by man.

In the scarcely populated Labrador agriculture does not play a great role in changing the landscape. It is only around a few small settlements that we find a few weeds, whilst the cattle in this Labrador area are also few (in the 'thirties perhaps five cows along the whole coast from Battle Harbour to Northwest River). The anthropochores mainly came with the schooners from Newfoundland and with the seeds imported by the few missionaries and officers of Hudson Bay. Note for instance how many of the anthropochores in the list in Chapter II were collected by WETMORE (1923) in a single day on the grassfield at Mud Lake (Gillesport); the only large »agricultural settlement» in the area for a long time. During our journey in 1937 I tried to keep an eye on the anthropochores and apophytes, but the number of species seen around the HBC-stations or near the fishermen's harbours were not many. Today, when fishing activity has as far as I know dramatically decreased along the Labrador coast, the old schooner harbours have been neglected and their anthropochorous flora is slowly disappearing. It seems that there is an older element of »*apophytes*», i.e. plants which easily invaded man-made habitats created by

the Indians and Eskimos (some *Carices, Draba incana, Potentilla norvegica, Rorippa islandica?*) of earlier times.

Now because of the sparsity of the population, instead of this slow penetration of the Labrador wilderness by the weeds and apophytes, the newly increased *logging-activity* will cause much greater changes in the original structure of the vegetation. When the spruce forests are cut we will have in southern Labrador the same increase in balsam fir and perhaps wild cherry, etc. (noted around Goose Bay and Northwest River) as is the general feature all over the Canadian taiga.

Of the 612 species listed in Chapter II only 20, i.e. about 3 per cent, are anthropochores, most of them typical cosmopolitan species, which can be found everywhere in the cold temperate region. However, in this respect the list is, of course, not up-to-date; the Goose Bay and the Knob Lake area must, by now, have at least double the number of such species. From the eastern shore of James Bay DUTILLY, LEPAGE and DUMAN (1958) report 20 introduced species, e.i. 3—4 per cent only. On the north shore of St. Lawrence ST. JOHN already 1922 found that the percentage of introduced plants was about 8.

*

In a following paper the author will return to the above mentioned and other questions, which arise when studying the list of vascular plants in Chapter II.

REFERENCES

ABBE, E. C. 1936. Botanical Results of the Grenfell-Forbes Northern Labrador Expedition 1931. Rhodora 38.

—»— 1955. Vascular Plants of the Hamilton River Area, Labrador. Contr. Gray Herbarium CLXXVI. Cambridge, Mass.

BALDWIN, W. K. W. 1958. Plants of the Clay Belt of Northern Ontario and Quebec. Nat. Mus. Canada Bull. 156. Ottawa.

BISHOP, H. 1930. The Austin Collection from the Labrador Coast. Rhodora 32. New York.

BLAKE, W. 1953. Vegetation and Physiography of the Goose Bay Area. M. S. Thesis. McGill Univ. Montreal (MS).

BOIVIN, B. 1955. Études batologiques I. Sous-genre Cylachtis (Raf.) Focke. Bull. Soc. Bot. France 102, 5—6. Paris.

—»— 1962. Études Astérologiques II. Natur. Canad. 89. Ottawa.

BRITTON, D. M. 1962. Dryopteris Dilatata (Hoff.) A. Gray in North America. Rhodora 64.

BÖCHER, T. W. 1952a. A study of the circumpolar Carex Heleonastes-amblyorhuncha complex. Acta Arctica V. København.

—»— 1952b. Contributions to the Flora and Plant Geography of West Greenland III: Medd. om Grønland 147. København.

—»— 1954. Oceanic and Continental Vegetational Complexes in Southwest Greenland. Ibid. 148.

DELABARRE, E. B. 1902. Report of the Brown and Harvard Expedition to Nachvak, Labrador. Bull. Geogr. Soc. Philadelphia II.

DUTILLY, A., LEPAGE E. et DUMAN, M. 1953. Contributions a la Flore du Bassin de la Baie d'Ungava. Contr. Arct. Inst. Cath. Univ. America, 4F. Washington, D.C.

—»— 1958. Contribution a la Flore des Iles et du Versant Oriental de la Baie James. Ibid. No. 9F.

DUTILLY. A. et LEPAGE, E. 1962. Exploration Botanique des Rivières Swampy Bay et Caniapiscau dans le Bassin de la Baie d' Ungava. Ibid. No. 11 F.

FAEGRI, K. 1960. The Distribution of Coast Plants. Oslo University Press.

FAGERSTRÖM, L. 1949. Vascular Plants collected by I. Hustich in Ontario and Quebec 1946. Memoranda Soc. Fauna et Flora Fenn. 24. Helsingfors.

FERNALD, M. L. 1950. Gray's Manual of Botany. 8th Ed. New York.

GARDNER, G. 1946. Liste des plantes récoltées sur la côte du Labrador et régions limitrophes. Bull. Soc. Bot. France. XCIII. Saint-Dizier.

GILLETT, J. M. 1954. A plant collection from the Mealy Mountains, Labrador, Canada. Can. Field Nat. 68. Ottawa.

—»— 1957. A Revision of the North American Species of Gentianella. Ann. Missouri Bot. Garden 44.

GRAYSON, J. F. 1956. The Postglacial History of Vegetation and Climate in the Labrador-Quebec Region. Ph. D. Thesis. Michigan Univ. (MS).

HARE, F. K. 1959. A Photo-reconnaissance Survey of Labrador-Ungava. Geographical Memoir 6. Ottawa.

HARPER, FR. 1958. Birds of the Ungava Peninsula. Univ. of Kansas Mus. Nat. Hist. Misc. Publ. 17. Lawrence, Kansas.

HUSTICH, I. 1939. Notes on the coniferous forest and tree limits on the East Coast of Newfoundland-Labrador. Acta Geogr. Helsinki — Helsingfors.

—»— 1949. On the Forest-Geography of the Labrador Peninsula. Ibid. 10.

—»— 1951. Forest-Botanical Notes from Knob Lake Area in the Interior of Labrador Peninsula. Nat. Mus. Canada Bull. 123. Ottawa.

HUSTICH, I. and PETTERSSON, B. 1944. Notes on the Vascular plants of the east coast of Newfoundland-Labrador. I. Memoranda Soc. Fauna Flora Fenn. 19. Helsingforsiae. — 1945. Idem II. Ibid. 20.

HULTÉN, E. 1956. The Cerastium alpinum complex. Sv. Bot. Tidskr. 50. Stockholm.

—»— 1958. The Amphi-Atlantic Plants and their Phytogeographical Connections. Kungl. Vet. Akad. Handl. IV, 7,1 Stockholm.

—»— 1962. The Circumpolar Plants I. Ibid. IV, 8,5.

JØRGENSEN, C., SØRENSEN, TH. and WESTERGAARD, M. 1958. The Flowering Plants of Greenland. Kong. Danske Vid. Selsk. 9,4. Kobenhavn.

KINDLE, E. M. 1924. Geography and Geology of Lake Melville District, Labrador Peninsula. Dept. Mines and Geol. Survey, Memoir 141. Ottawa.

LEPAGE, E. 1956. Études sur quelques plantes americaines. IV. Carex hybrides. Naturaliste Canadien 83. Québec.

—»— 1960. Hieracium Canadense Michx. et ses alliees en Amerique du Nord. Ibid. 82.

LOW, A. P. 1895. Exploration through the interior of the Labrador Peninsula. Geogr. Journ. V, 6. London.

LÖVE, D., KUCYNIAK, J. and JOHNSTON, G. 1958. A Plant collection from Interior Quebec. Ibid. 85.

LÖVE, D. 1960. The Red-fruited Crowberries in North America. Rhodora 62.

MACOUN, J. M. 1895. Liste des plantes que l'on sait se rencontrer sur la côte et dans l'intérieur de la péninsule du Labrador. Comm.Geol. Canada, Rap. ann. VIII. Annexe VI. Ottawa.

POLUNIN, N. 1940. Botany of the Canadian Eastern Arctic. Nat. Mus. Canada Bull. 92. Ottawa.

PORSILD, A. E. 1944. Notes from a Labrador peat bog. Can. Field Nat. 58. Ottawa.

—»— 1949. A new Antennaria from Northern Ungava. Rhodora 47.

—»— 1950. The Genus Antennaria in Northwestern Canada. Can. Field Nat. 64. Ottawa.

—»— 1957. Illustrated Flora of the Canadian Arctic Archipelago. Nat. Mus. Canada Bull. 146. Ottawa.

RAUP, H. M. 1943. The willows of the Hudson Bay Region and the Labrador Peninsula. Sargentia 4. Lancaster, Pa.

RAYMOND, M. 1950a. Esquisse Phytogeographique du Québec. Mém. Jard. Bot. Montréal 5. Montréal.

—»— 1950b. Les Cyperacees de l'Anticosti. Can. Journ. Res. C, 28. Ottawa.

—»— 1951. Sedges as Material for Phytogeographical Studies. Mem. Jard. Bot. Montréal 20.

—»— 1957. Le Carex rotundata en Amerique du Nord. Ibid. 49.

ROUSSEAU J. et RAYMOND, M. 1950. Betula Michauxii Spach. in Northeastern America. Rhodora 52.

SØRENSEN, TH. 1954. New species of Hierochloë, Calamagrostis and Braya. Medd. om Grønland 136, 8. København.

ST. JOHN, H. 1922. A botanical exploration of the North Shore of the Guld of St. Lawrence. Dept. of Mines, Memoir 126. Ottawa.

TANNER, V. 1944. Outlines of the Geography, Life and Customs of Newfoundland-Labrador. Acta Geogr. 8. Helsinki — Helsingfors.

WENNER, C. 1948. Pollen Diagrams from Labrador. Geogr. Annaler 1947. Stockholm.

WETMORE, R. H. 1923. Plants of the Hamilton Inlet and Lake Melville Region, Labrador. Rhodora 25.

VIERECK, L. A. 1957. The Flora of Gerin Mountain, Central Quebec-Labrador. Copy of M. Sc. Thesis. Univ. of Colorado, Boulder. (MS).

WILTON, W. C. 1959a. Forest Types of the Grand Lake and Northwestern Lake Melville Areas of Labrador. Forest Research. Div. Techn. Note 83. Ottawa.

—»— 1959b. The Forests of the Sandwich Bay Area, Labrador. Ibid. Mimeo 59, 10. Ottawa.

WOODWORTH, R. H. 1927. Interesting Plants of Northern Labrador. Rhodora 29.

ACTA GEOGRAPHICA 17, N:o 4

ON RELATIONS BETWEEN GEOLOGY AND MULTIPLE SCLEROSIS

BY

MARTTI SALMI

THE GEOLOGICAL SURVEY OF FINLAND, OTANIEMI

HELSINKI 1963

PRINTED BY TILGMANN
HELSINKI 1963

ON RELATIONS BETWEEN GEOLOGY AND MULTIPLE SCLEROSIS

Dr. Harry V. Warren, professor of geology and geography at the University of British Columbia, Vancouver, Canada, has published a preliminary note (1959) on his investigations where he attempts to clarify the possible connection between geological factors and multiple sclerosis. He compared areas where this illness of the central nervous system is frequent and stated that in places their forms resemble fans and anomaly figures caused by ore blocks, or fan-like broadening areas in the direction of transportation of the continental ice starting from the source of material. Such concentrations of the illness are found in the areas of former continental ice, e.g. in Sweden, Norway and Denmark, in Northern Scotland and Ireland, and in places in North America, as in southeastern Ontario, southwestern Quebec and central Nova Scotia. On the other hand, multiple sclerosis also occurs outside the areas of ancient continental glaciation, and hence local concentrations of the illness cannot be causally connected only with continental ice and material transported by it. Investigations concerning the local features of this illness are not available in Finland.

The illness mentioned above has been testified frequently in some places in Scandinavia and northern Scotland. In these areas there are several separate islets where the illness is quite rare. Geologically these islets occur in old gneiss areas. The worst concentrations in Sweden and Norway coincide with the areas of Eocambrian sediments and the Telemarks schists of Norway — the latter also being old sediments- and in Scotland with the occurrences of Old Red Sandstone. In Canada multiple sclerosis seems to be associated mainly with limestone, which in places is dolomitic. Accordingly the areas of sedimentary rocks appear to mark the densest concentrations of the illness. Also attention is paid to the fact that the bedrock in the areas infested by the illness contains lead above the normal amount.

Multiple sclerosis is abundant in Switzerland. The illness has been subject to research for scores of years and a distribution map (Georgi & Hall 1960) is one of the results (Fig. 1.) It shows that multiple sclerosis occurs mainly in

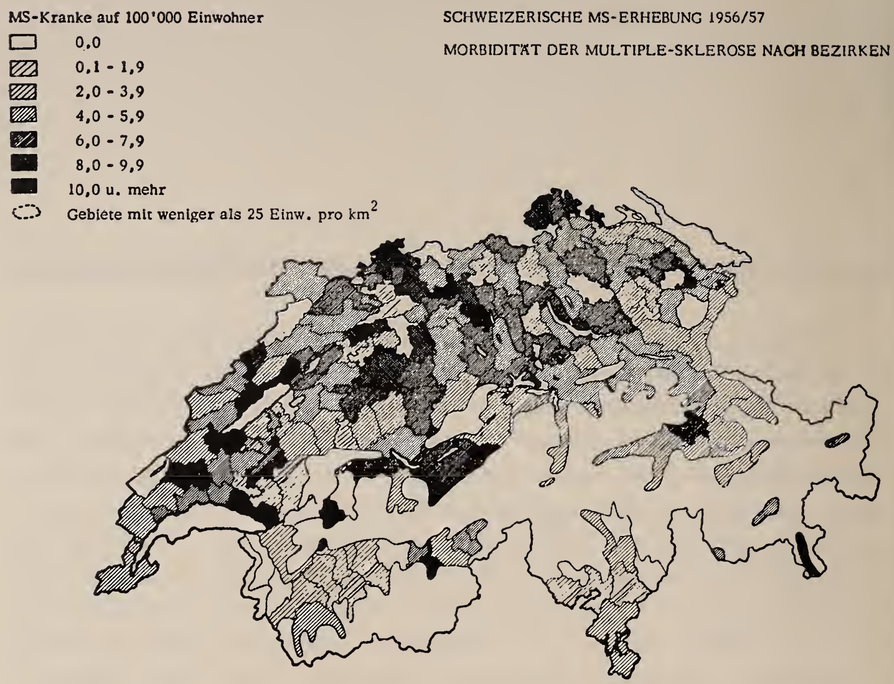


Fig. 1. Occurrences of multiple sclerosis in Switzerland after *Georgi* and *Hall* (1960).

the northern parts of Switzerland while there are large areas in the south where the illness is entirely lacking or occurs only in places. The statistics for 1957 show that there were 2 636 persons suffering from multiple sclerosis — an average of 0,51 $^0/_{00}$ or 51 cases among 100 000 inhabitants. The amount of female patients is more then twice that of male, and the majority is formed by the 20—40 age group. A good third of all cases are complete invalids.

To elucidate the causes of the illness the two Swiss physicians mentioned above, Georgi and Hall (op.cit.) carried out an expedition to East Africa which lasted for several months. It went as far as the Equator and included Ethiopia. Not a single case of multiple sclerosis was met with in the area. Elsewhere in Africa the illness is no more common. One Zulu woman is known to suffer from it, and multiple sclerosis is found in some immigrants from Europe and India to Africa. On the other hand, some black and white people who have moved from Africa to Europe and North America have acquired this illness in their new surroundings. It may also be mentioned that multiple sclerosis

does not occur in the Yemen, not even among the Jews, although it is frequent among them in Israel (Georgi 1960 a and b, Georgi & Hall, op.cit). The investigators mentioned above have concluded that multiple sclerosis is not caused by hygienic conditions, climate or racial factors. Instead they assume that geological factors and trace elements in particular do play an important role in causing multiple sclerosis. Consequently, extensive research on trace elements in spring and city water has been initiated and the results will be compared with the water analyses of Addis Ababa.

The author has compared the map in Fig. 1 with the geological map of Switzerland (von Moos & de Quervain, 1950). Several geologically different zones running from southwest to northeast are distinguished in Switzerland. Farthest north in the zone of the Jura mountains limestones and marl predominate (Numbers 3 and 4 in Fig. 2). South of this zone — in the so-called molasse-area (1 and 2) — there are sediments transported from the Alps during the Tertiary, and transformed to conglomerates, sandstones and marl in the course of time. Uppermost in the area are quaternary sediments. The molasse area is followed by the Calcareous alps in the south, formed by sediments (5 and 6). They comprise chiefly limestone, marl and clay schist. Multiple sclerosis is

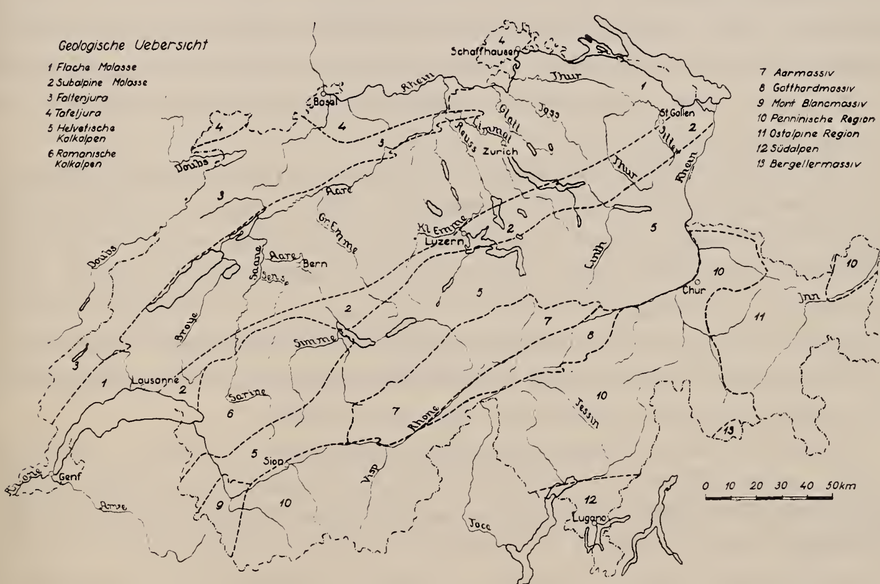


Fig. 2. Main features after v. *Moos* and *Quervain* (1950).

most frequent in the above geological zones. In the east and west of the calcareous alps, however, there are large areas where it is not met with.

The Central Massif (7—9) of the Alps proper with its snow caps and glaciers is mainly composed of crystalline rocks. Granites, gneisses and schists form the majority, but in places also former sediments, at present sandstones, clay stones and limestones, are found. In the south of Switzerland there is the large gneiss massif of the Pennines (10). The East Alps (11) include gneisses and schists, and also Trias dolomite. The gneissic basement of the Southern Alps (12) is covered by carbonaceous sedimentary rocks in the area surrounding Lake Lugano. In the last-mentioned area multiple sclerosis occurs rather frequently, but it is only sporadic in the Alpine zone of crystalline rocks. These local concentrations of the illness in the granite-gneiss area coincide with places where the lead content is the lowest in Switzerland, as can be verified on the basis of the map by Kündig and de Quervain (1953) which shows the mineral resources of Switzerland.

In Switzerland there seems to exist some kind of correlation between the frequency of multiple sclerosis and the distribution of rocks, possibly influenced by the distribution of lead. At the same time it may be stated that different parts of Switzerland deviate from each other in more than the geological respect. The southern part of the country is a sparsely settled mountainous area where stock raising and small-scale agriculture form the main source of livelihood. The northern part is a densely inhabited industrial area with metal, textile and chemical industries — particularly the watch and clock industry of the Juras, where agriculture and stock raising are also carried on as in the Alpine region to the south.

As high lead content in the bedrock and the abundance of multiple sclerosis are assumed to be connected, the question has arisen whether lead tetraethylene mixed with benzene would increase the lead content of the surroundings where motor cars are greatly used, and whether thus additional information could be obtained concerning the relations between the illness and geological factors, especially lead occurrences. Towards this end Warren has started collaboration with physicians and geologists from different countries. In accordance with his wishes the author has collected data from Finland.

Since 1957 tetraethylene of lead has been added to benzene to raise its octane value. There are two kinds of leaded benzene. One contains 0.2 ml (regular) and the other 1.9 ml (premium) per gallon. Lead is not added to fuel for buses.

INVESTIGATIONS IN FINLAND

Data collected

To solve the problem whether the tetraethylene of lead added to benzene caused increases in lead content in Finland, plant samples were taken at three different places in the country, where the frequency of motor car traffic is very different, on September 17, 1960. Maple (*Acer*) was chosen as the test plant. Its leaves and 1—3 year old twigs were studied separately. The samples were dried at 110°C and then burned to ashes at 450°C. The spectral analyses of the plant ashes were carried out by Mr. Arvo Löfgren, Mag. Phil. at the Chemical Department of the Geological Survey of Finland.

Samples and their localities were the following:

A. Helsinki. Vanhankirkon puisto (the park of the Old Church). Maple, about 12 m high, grows 7 m from the driveway near the corner of Bulevardi and Annankatu streets. Its leaves and twigs were very sooty and covered by thick dust. Motor car traffic in Bulevardi is among the most intense in Helsinki.

Sample 1. Maple leaves containing 11.79 per cent ash.

Sample 2. Maple twigs with 5.83 per cent ash.

B. Road side Helsinki—Porvoo, some 17 km east of Helsinki. Samples were taken 5 m from the macadamized highway of a 3 m high maple. Heavy traffic passes along this road. Maple leaves and twigs were thinly coated by dust. There is a small centre of settlement 1 km from the site of the maple.

Sample 3. Maple leaves with 9.39 per cent ash.

Sample 4. Maple twigs with 5.86 per cent ash.

C. Grötholmen, Sipoo. A small island in the Gulf of Finland about 25 km east of Helsinki and some 400 m south of the mainland. The maple grows ca. 5 m from the shore and one meter above the average sea level. It is about 8 m high. Its leaves and twigs were pure. In summer time slight motor boat trafic passes the locality.

Sample 5. Maple leaves with 9.57 per cent ash.

Sample 5. Maple twigs with 3.48 per cent ash.

Results of the analyses

In addition to lead also Cu, Zn, Ti, V, Ni, Co and Cr were taken into consideration. The results are given as millionths of a percent (ppm) in Table 1. The portion of each element is given in column 1 for ash, and in column 2 for the dry matter of the samples. Because all the samples contain less than 100

ppm of vanadine, nickel and chrome and less than 50 ppm of cobalt, or less than could be measured with the method used these values were omitted in table. Some samples also contain zinc and titanium below the sensitivity limit of the analytical method.

Table 1. Lead, copper, zinc and titanium contents of the samples as ppm of the ash (1) and dry matter (2).

No. of sample	Pb		Cu		Zn		Ti		Ash content %
	1	2	1	2	1	2	1	2	
1	240	28	200	24	600	71	750	89	11.79
2	230	13	120	7	510	30	100		5.83
3	100	9	210	20	600	56	480	45	9.39
4	35	2	90	5	100		100		5.86
5	16	1.5	54	5	100		100		9.57
6	37	1.4	100	3.5	100		100		3.48

The ash contents of the samples show that the leaves of the trees in all cases contain more ash than the twigs and the samples from Helsinki more than the others. The ash contents from different localities are surprisingly of the same order of magnitude in spite of the fact that the samples taken from Sipoo were pure, while on the other hand those from Helsinki were covered by much soot and dust.

The lead content of the ashes from different localities deviates distinctly. Lead is most abundant in the Helsinki samples and least in those taken from the Sipoo archipelago. Differences are noted between leaf and twig samples of the same trees. In the first two cases the leaves contain more lead than the twigs, but in the maple of Sipoo the ratio is inverse, as is the case in numerous leaf and twig samples of the wild rosemary (*Ledum palustre*) from the Isosuo of Vihanti, shown earlier by the present author (Salmi 1956). Because this refers to plants growing far from highways, those maples growing along Bulevardi in Helsinki as well as on the road side towards Porvoo must have accumulated lead in their leaves. One possible source is therefore lead from the fuel of passing motor cars. Lead is considerably scarcer in the Sipoo archipelago, apparently due to the scant motor traffic when compared with both other localities under review.

In all cases the dry matter of maple leaves and twigs contains more lead in the leaves than in the twigs, although the difference is slight in the Sipoo

samples. These results prove clearly that the lead content decreases from Helsinki to Sipoo and that differences between the various sampling points are distinct.

The copper contents when compared with the lead ones are of about the same order and they vary in the same way as the lead contents. The twigs of the Sipoo maple also contain more copper than the leaves, as do the *Ledum palustre* samples from the Isosuo of Vihanti (Salmi, op.cit.). Marmo (1953) stated the same ratio in his investigations. The copper content clearly decreases from Helsinki toward Sipoo.

Zinc deviates from the former. It occurs in high proportions in the maple leaf and twig samples of Helsinki, as well as in the maple leaves on the Porvoo road side, but scantily in the twigs, and in both samples from Sipoo. Titanium deviates from zinc only because its amounts in all twig samples are so low that the content could not be more closely determined.

The investigations show that in addition to lead, copper, zinc and titanium are more abundant in the samples from Helsinki than from elsewhere, and scantiest in the samples from Sipoo. Further, the proportions between the elements in Table 1 are similar in leaf and peat samples. Copper, zinc and titanium are not added to benzene, yet their contents increase along the traffic routes in accordance with those of lead. Some other factor than benzene must cause their rise, but at the same time one may ask to what extent the increase of lead is due to tetraethylene of lead in benzene. It is conceivable that along the roads with heavy traffic the source of trace elements accumulated on maples would be partly the friction surfaces of the metal parts of vehicles and the fine matter detached from the surfaces of macadamized roads which spreads out to the surroundings as fine dust. Also the source may be trace elements in the exhaust of different fuels.

Lead occurrences and the frequency of multiple sclerosis in Finland

The bedrock of Finland in general contains only scanty traces of lead. On the map in Fig. 3, based on the schist and rapakivi areas after Simonen (1960), even the smallest finds of galena (PbS) are marked from the card index of the Geological Survey. Some boulder finds are also included. The occurrences seem to coincide with limestones, rapakivi granite areas and contacts between schists and other rocks. The most south-western occurrences are in the Åland Islands, and the most southeastern, between Pernaja and Lappeenranta, are in the Viipuri rapakivi area. The galena occurrences of South, Southwest and Lake Finland as well as those of South and Central Bothnia are located in the zone

Fig. 3. Occurrences of galena in Finland plotted on Precambrian map by *Simonen* (1960). 1 = Svecofennidic schists, 2 = Caledonian schists, 3 = rapakivi granites. Arrows show the movement and transportation directions of continental ice.

of Svecofennian and Karelian schists. The following localities contain marked traces of galena: the Vihanti mine about 70 km south of Oulu, the Korsnäs mine some 40 km south of Vaasa, the Orijärvi-Aijala mines in Southwest Finland and, associated with them, several less significant occurrences in the parishes of Kisko, Tenhola, Lohja, Karjalohja, and Attu in Parainen. Worth mentioning further are the eastern part of Åland Islands with the archipelago and the rapakivi area of Viipuri.

At some places the direction of advance of the continental ice is marked (after Okko, 1960) on the map with arrows. In those directions lead-bearing material may have been transported by ice from its source, and mixed with till spread out on fan-shaped areas. Transportation of material is usually limited to a few hundred meters or some kilometers excluding possible solitary boulders from far away. Thus the assumed danger-factor would be limited to the immediate vicinity of the occurrences.

Aa far as the correlation between lead distribution and multiple sclerosis would seem valid, the lead occurrences mentioned above would geologically offer the most striking evidence of correspondence with the illness. Particularly in southwestern and southern Finland the density of the cases exceeds that elsewhere, but, on the other hand, it must be borne in mind that all galena occurrences are not yet known in Finland. Warren (op.cit.) also expressly points out that multiple sclerosis is associated not only with the distribution of economical lead ores, but that the illness is also met with in areas where the bedrock contains more lead than is general.

If lead added to benzene causes multiple sclerosis, then the inhabitants along highways with heavy traffic and in the largest cities and industrial areas would be most exposed to the illness. This factor cannot be as severe in Finland as it is in the world's large industrial and population centres.

Information obtained from physicians in this field concerning the occurrence of multiple sclerosis in Finland shows that the illness is met with here but no statistics exist of the number of patients. Nor is there any clarification as to whether the cases are concentrated more abundantly in some localities than in others. As far as I know, attention will be paid to the occurrence and distribution of the illness in the near future. I hope that this treatise will be of assistance when comparisons are made to solve whether there is any causal connection between multiple sclerosis and geological factors — in the first place, lead.

Summary

Multiple sclerosis has been proved to occur mainly in the areas of ancient continental ice. There, local areas of the disease resemble block fans. The worst concentrations of cases seem to be located in areas where limestones, schists and in general sedimentary deposits form the bedrock and where the amount of lead exceeds the average.

Multiple sclerosis is most noticeably distributed in some areas of North America, North Scotland, the Scandinavian countries and Switzerland. According to statistics for 1957 there were in Switzerland altogether 2 636 multiple sclerosis patients or 51 cases to 100 000 inhabitants. The amount of female patients outnumbered by more than twice that of the male ones and the majority fell in the 20—40 age group. The illness occurred more frequently in the northern parts of the country (Fig. 1) and its distribution would seem to be connected with the geological factors shown in Fig. 2. The illness was practically not found at all in Africa, but persons moving elsewhere may become sufferers in new conditions.

It is assumed that multiple sclerosis is not caused by hygienic conditions, climate or racial factors. Instead it is regarded possible that trace elements, including lead, may cause the illness.

It has been suggested that tetraethylene of lead added to benzene would increase lead content where motor vehicles are heavily used. It was proposed that the relation of lead to the illness in question be further elucidated. In this respect research material was collected in Finland.

The samples comprised maple leaves and twigs, whose ashes were analyzed spectrographically. They were taken from three different localities, which deviated markedly in traffic density. They were on Bulevardi, Helsinki, on Porvoo highway ca. 17 km east of Helsinki, and in the Sipoo archipelago, ca. 25 km south of Helsinki. The samples from Helsinki contained most, and those from Sipoo least, lead. (Table 1). Similar differences were found in the copper, zinc and titanium contents. They are, however, not added to benzene, so that high contents may be derived from the trace elements detached from the friction surfaces of metal parts as well as dust from the road surface and trace elements in the smoke of different fuels. Thus the extent to which the increase of lead is caused by the use of leaded benzene remains unsolved.

The author has compiled a map of the occurrences of galena in Finland (Fig. 3). It may be of assistance when information concerning the distribution of multiple sclerosis is mapped and the relation between lead and the illness is compared.

Bibliography

Georgi, F, 1960 a. Probleme der multiplen sclerose. Schweitzerischen Medizinischen Wochenschrift. 90. Jahrgang, Nr 50.

—»— 1960 b. Geomedizinische, sozialhygienische und medizinalpolitische Aspekte in Ostafrika. Münchener Medizinische Wochenschrift. 102. Jahrgang, Nr. 45.

Georgi, F & Hall, P. 1960. Studies on multiple sclerosis frequency in Switzerland and East Africa. Acta Psych. et Neurol. Scand. Suppl. 147.

Kündig, E & de Quervain, F. 1953. Fundstellen mineralischer Rohstoffe in der Schweiz. 2. Ausg. Geotechnische Kommission de Schweitz. Naturforschenden Gesellschaft.

Marmo, Vladi, 1953. Biogeochemical investigations in Finland. Economic Geology, Vol. 48, No 3.

v.Moos, A. & de Quervain, F. 1950. Programm und graphische Beilagen. Exkursion A 1. Schweitz. Mineralog. und Petrograph. Gesellschaft.

Okko, Veikko, 1960. Kivennäismaalajit. — Minerogenic Deposits. Suomen kartasto — Atlas of Finland. Otava, Helsinki.

Salmi, Martti, 1956. Peat and bog plants as indicators of ore minerals in Vihanti ore field in Western Finland. Bull. Comm. géol. Finlande 175.

Simonen, Ahti, 1960. Pre Quaternary rocks of Finland. Ibidem 191.

Warren, Harry V., 1959. Geology and multiple sclerosis. Nature, Vol. 184.

ACTA GEOGRAPHICA 17, N:o 5

FIELDS OF POPULATION CHANGE
around the 60th Parallel Capitals and Maritime Cities
OSLO — STOCKHOLM — HELSINKI
about 1960

BY

REINO AJO

HELSINKI
1963

PRINTED BY TILGMANN
HELSINKI 1963

The fields

The term *field* implies variations in space and time although here we are considering only space phenomena and fields defined by the confines wherein the field variation is consistently dependent on the space coordinates. The field variates are rates, per thousand, of migration, and rates of total or gross change of population, according to the structure of the statistical sources used. The first mentioned variates are rates of in-, out-, and net-migration, whereas the last variate represents the overall rate of change. Collectively, they all display *population change* which is the term used in the title.

In the endeavour to throw light upon the field-forming factors just referred to, this study concentrates on the variations in space. To achieve this, the variation in time is brought to a standstill by considering the statistics pertaining to a fixed time interval, *e.g.* a year. We shall return to this point later.

The elimination of the time variation makes more important the question, how to locate the assay in space. This writer has in his earlier studies observed that the variation is strongest in the vicinity of big cities where the actual statistical areal elements are also smallest and most numerous. Consequently, the fields of big cities give more observed points with more information for finding and describing the dependence here sought for.

Observations concerning the field of a single city do not suffice, however, because a single result would leave one in doubt whether the dependence therein found is purely accidental or peculiar only to the particular field of that city. Not until the same feature appears in all or most of several test subjects, may one conclude that it is likely, after all, to be a characteristic trait. More test subjects are thus needed.

Assuming that similar stimuli give rise to similar effects, one may really expect to find more evidence of a particular dependence when the test is replicated in possibly similar conditions. The formal similarity, however, is not, and need not be, total. It is most likely to be restricted to some characteristic feature which is made observable by an appropriate technique of analysis.

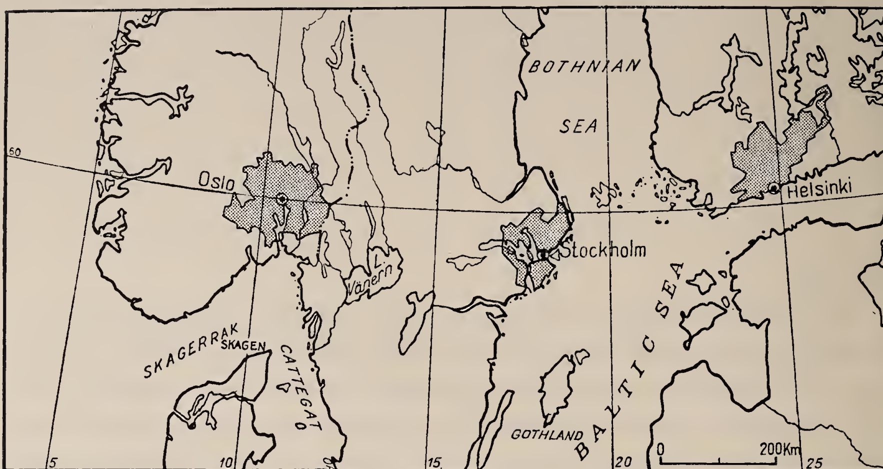


Figure 1. The Subject Fields.

Field sites

If the technique of replication is applied to different test subjects, *i.e.* fields under possibly similar conditions, the information obtained is still more valuable because the idiosyncracies of an individual test subject may then be revealed and prevented from vitiating the conclusions arrived at.

In the present study the Nordic capitals on the 60th parallel — Oslo, Stockholm, and Helsinki — are equally suitable test subjects because there are in the world few if any big cities with their environs so strikingly similar in most aspects of their life. Their otherwise manifold resemblance is geographically further emphasized by the fact that these cities lie almost on the same latitude (*v.* Fig. 1.).

Time setting and
Statistical sources

While field phenomena imply variations not only in space but also in time, one might suspect that the observed dependence was a chance occurrence peculiar only to a particular moment of time. To help counteract the suspicion that a point of time was deliberately chosen, the time incidence is taken by basing the study on the most recent statistics which are by chance available. This introduces some divergence in the timing of the statistics applied. It is, however, in this connexion of no importance.

Thus the statistics referring to Oslo give the »Figures of Population in Rural Districts and Towns at January 1, 1960» (*Norges Officielle Statistikk* A 30; Oslo, 1961), whereas the figures referring to Stockholm have the dates December 31, 1960 and 1961 (*Sveriges officiella statistik*: *Folkmängden inom Administrativa områden*, Stockholm, 1961 and 1962), and, lastly, the figures for Helsinki are for December 31st, 1960, and are given in the »Official Statistics of Finland. Vital Statistics.» (*Suomen Virallinen Tilasto*; VI A: 119. Helsinki, 1962) of which the printing proofs were kindly placed at the disposal of this writer. In view of these minor differences, the present study is in its title timed at »about 1960».

The field co-ordinates

In this context use will be made of only one space-coordinate. It is based on the direct, *i.e.* 'as the crow flies', distance (r) from the city centre to the visual centre of the respective map figure. The city proper and all areal elements used for statistical purposes within 10 km radius of the city-centre will be grouped to form the class centred at zero distance (0-class). The other classes are consecutive 10 km zones with their central distances (r) successively at 15, 25, 35 kms etc., from the city centre.

Combined processing of data and

Demarcating of the fields

Arranging the statistical material according to the principles just explained supplies us with Tables 1—3. Each table begins with the central city and proceeds by listing the nearest contiguous communes with necessary care taken not to account for any commune which would decidedly impair the otherwise consistent class-value and its fit on the simultaneously constructed plot. At last, at the extreme periphery, one must reject all contiguous communes, which means that the list is complete.

In these tables the observed values deduced from the class-totals are set in italics. Moreover, each row of communal data is numbered for cross reference and assistance when considering the plots in Figs. 2—4 showing the fields arrived at in the delimiting process.

Particular attention is drawn to the fact that the determining of boundaries has in this connexion been carried out from the centre, and by internal criteria, whereas one has until now got used to methods built upon the existence of an equilibrium point of opposed variations which, however, may leave one helpless in trying to find a needed balancing item.

Table 1. Statistical Data. Field of Oslo. Year 1959.

Class centra x =	Ref. No. v. Figure 2.	Commune	POP.	Migration 1st January 1959 —1st January 1960			Excess of births
				IN	OUT	NET	
0	1	OSLO	471511	19988	15881		1693
				42.4	*33.7*	*8.7*	*3.59*
3.9	2	Baerum	55425	5034	3772		763
	3	Asker	16949	1539	1205		240
	4	Nesodden	5930	525	457		105
	5	Oppegård	6999	554	441		89
	6	Lørenskog	10321	927	645		154
	7	Raelingen	4713	571	265		52
			100337	9150	6785		1403
				91.2	*67.6*	*23.6*	*13.98*
5.0	8	Ås	6016	664	631		82
	9	*Drøbak*	2735	328	180		16
	10	Frogn	2989	253	280		48
	11	Ski	7670	659	558		120
	12	Kråkstad	1642	104	145		15
	13	Enebakk	3858	255	244		26
	14	Skedsmo	12273	904	758		128
	15	Lillestrøm	10281	606	524		127
	16	Fet	4562	204	200		24
	17	Nittedal	7246	516	604		82
	18	Gjerdrum	2011	138	143		27
	19	Sørum	4164	315	283		31
	20	Norderhov	14780	727	765		158
	21	Hole	2948	200	223		26
	22	Lier	13215	839	806		116
	23	Røyken	7772	431	397		57
			104162	7143	6741		1083
				68.6	*64.7*	*3.9*	*10.40*
5.9	24 25	*Hvitsten* Vestby	4434	306	275		39
	26	Hobøl	2688	197	127		9
	27	Spydeberg	2872	133	167		19
	28	Blaker	2329	177	126		17
	29	Ullensaker	11351	1015	1077		115
	30	Lunner	5082	243	272		53
	31	Jevnaker	4493	168	175		4
	32	*Drammen*	30925	1630	1487		125
	33	*Holmsbu* Hurum	6894	244	315		11
	34	*Svelvik*	1210	58	64		3
	35	Strømm	2354	208	199		25
	36	Skoger	13746	772	742		122
			88378	5091	5026		542
				57.6	*56.9*	*0.7*	*6.13*

(Contd.)

Class centra x =	Ref. No. v. Figure 2	Commune	POP.	Migration 1st January 1959 —1st January 1960 IN	OUT	NET	Excess of births
6.7	37	Hønefoss	4268	400	274		22
	38	Trøgstad	4094	185	185		26
	39	Askim	9395	367	404		78
	40	*Son*	482	25	30		—5
	41	SøndreHøland	2281	73	83		7
	42	NordreHøland	4097	173	186		34
	43	Aurskog	3142	93	145		27
	44	Nannestad	5577	317	330		53
	45	Tyristrand	1708	69	44		—2
	46	Modum	12072	446	545		38
	47	Nedre Eiker	11502	579	455		107
	48	Sande	5004	228	248		41
			63622	2955	2929		426
				46.4	*46.0*	*0.4*	*6.69*
7.4	49	Gran	5433	271	265		52
	50	Øvre Eiker	12475	598	611		115
	51	*Moss*	20458	941	805		197
	52	Mysen	2507	125	165		23
	53	Eidsberg	6180	273	388		56
	54	Skiptvet	2593	112	157		14
	55	Våler	2388	164	183		11
	56	Setskog	873	9	24		6
	57	Nes	11560	449	597		98
	58	Eidsvoll	11843	516	522		69
	59	Hurdal	2236	89	85		17
	60	*Holmestrand*	2107	82	99		—2
	61	*Horten*	13292	777	774		84
	62	Hof	2417	81	92		5
	63	Botne	4397	172	172		45
			100759	4659	4939		790
				46.2	*49.0*	*—2.8*	*7.84*
8.1	64	Rødenes	1390	62	100		17
	65	Rømskog	728	29	25		7
	66	Brandbu	6545	212	252		65
	67	*Kongsberg*	9596	496	453		54
	68	Ådal	3491	124	179		19
	69	Krødsherad	2033	61	89		—12
	70	Flesberg	2299	109	112		—2
	71	*Åsgårdstrand*	489	57	46		9
	72	Våle	2774	149	139		20
	73	Borre	5719	383	368		68
	74	Ramnes	2633	144	187		30
			37697	1826	1950		275
				48.4	*51.7*	*—3.3*	*7.30*
		Grand Totals	966466	50812	44251		6212

Table 2. Statistical Data. Field of Stockholm. Year 1961.

Class Center	No.	& Name of Commune (*v.* Fig. 3.)	Inhabitants at 31/12 1961	Inhabitants at 31/12 1960	Relative Change
0	1	STOCKHOLM	807127	806903	
	2	*Lidingö*	30807	29424	
	3	*Stocksund*	5000	4992	
	4	*Nacka*	22102	20740	
	5	*Solna*	52312	51094	
	6	*Djursholm*	7446	7386	
	7	*Sundbyberg*	27058	27059	
	8	*Danderyd*	12501	11627	
			964353	959225	*5.3*
3.9	9	Boo	6734	6674	
	10	*Saltsjöbaden*	5549	5311	
	11	*Vaxholm*	3938	3792	
	12	Sollentuna	26003	25182	
	13	Tyresö	7676	5988	
	14	Botkyrka	12834	11744	
	15	*Täby*	23025	21456	
	16	Järfälla	22178	19212	
			107937	99359	*82.8*
5.0	17	Färingsö	3084	3134	
	18	Gustavsberg	5353	5169	
	19	Huddinge	33127	29490	
	20	Salem	2488	2299	
	21	Österåker	6453	5962	
	22	Upplands Väsby	9766	8820	
	23	Grödinge	1973	1961	
	24	Österhaninge	10196	9385	
	25	Värmdö	2052	1962	
	26	Ekerö	3954	3865	
	27	*Södertälje*	35314	33152	
	28	Vallentuna	5942	5525	
			119701	110724	*77.9*
5.9	29	Västerhaninge	7072	6478	
	30	Upplands Bro	3978	3913	
	31	Össeby	1790	1825	
	32	Östertälje	2857	2731	
	33	Ljusterö	1010	1032	
	34	Märsta	7111	6301	
	35	Enhörna	902	951	
	36	Ösmo	2222	2186	
	37	Sorunda	2755	2791	
	38	*Sigtuna*	3281	3212	
	39	Djurö	1495	1526	
			34473	32946	*45.3*

(Contd.)

Class Center	No.	& Name of Commune (*v.* Fig. 3.)	Inhabitants at 31/12 1961	1960	Relative Change
6.7	40	Turinge	2784	2706	
	41	Järna	5047	4890	
	42	Roslags-Länna	2457	2556	
	43	Hölö	2122	2143	
	44	Skepptuna	2745	2836	
	45	Knivsta	3832	3830	
	46	*Nynäshamn*	9666	9421	
	47	Håbo	2840	2826	
	48	Sjuhundra	5251	5186	
			36744	36384	*9.8*
7.4	49	*Mariefred*	2519	2562	
	50	Stallarholmen	2276	2360	
	51	*Trosa*	1391	1313	
	52	Vagnhärad	2888	2983	
	53	Norra Trögd	2808	2809	
	54	Södra Trögd	1947	1959	
	55	Blidö	910	928	
	56	*Norrtälje*	9078	8871	
			23817	23785	*1.3*
8.1	57	Södra Hagunda	1515	1564	
	58	Almunge	1839	1843	
	59	Frötuna	1828	1843	
	60	Lagunda	2884	2909	
	61	Lyhundra	4192	4266	
			12258	12425	*—13.5*
8.7	62	Knutby	2638	2725	
	63	Åsunda	3044	3092	
			5682	5817	*—23.5*
9.2	64	Väddö	3042	3118	*—24.7*
		Grand Totals	1308007	1283783	

Table 3. Statistical Data. Field of Helsinki. Year 1960.

Class centra x =	Ref. v. Figure 4.	Commune	POP.	Migration 1st January 1960 —31st December 1961			Excess of births
				IN	OUT	NET	
0	1	HELSINKI	463212	24657	18840	5817	3398
				53.2	*40.7*	*12.6*	*7.34*
3.9	2	*Kauniainen*	2940	373	346	27	29
	3	Helsinki mk	42509	5887	3497	2390	730
	4	Espoo	58180	10295	4291	6004	936
			103629	*159.8*	*78.5*	*81.3*	*16.35*
5.0	5	*Kerava*	9394	1043	868	175	140
	6	Tuusula	13605	1442	1165	277	189
	7	Kirkkonummi	5902	1127	492	635	81
			28901	3612	2525	1087	401
				125.0	*87.4*	*37.6*	*14.19*
5.9	8	Nurmijärvi	13439	1011	916	95	104
	9	*Järvenpää*	12175	1194	909	285	147
			25614	2205	1825	380	253
				86.1	*71.3*	*14.8*	*9.87*
6.7	10	Siuntio	2659	213	235	—22	1
	11	Vihti	11132	701	788	—87	23
			13791	914	1023	—109	24
				66.3	*74.2*	*—7.9*	*1.74*
7.4	12	*Hyvinkää*	19877	1954	1696	258	254
	13	Hyvinkää mk	6951	595	528	67	66
	14	*Lohja*	8569	606	500	106	133
	15	Lohja mk	10637	614	700	—86	46
	16	Inkoo	3934	236	201	35	4
	17	*Karkkila*	4757	316	353	—37	50
	18	Pyhäjärvi	3485	108	151	—43	11
	19	Mäntsälä	10903	474	514	—40	36
			69113	4903	4643	260	600
				70.9	*67.2*	*3.7*	*8.68*
8.1	20	Pusula	3676	133	215	—82	31
	21	Sammatti	1264	56	80	—24	—8
	22	Nummi	3832	140	168	—28	—13
	23	Pukkila	2316	103	104	—1	19
	24	*Riihimäki*	20109	1397	1228	169	220
	25	Hausjärvi	9041	578	658	—80	48
	26	Karjalohja	2149	68	156	—88	—2
	27	Loppi	8868	430	542	—112	45
			51255	2905	3151	—246	340
				56.6	*61.4*	*—4.8*	*6.63*

(Contd.)

Class centra x =	Ref. v. Figure 4.	Commune	POP.	Migration 1st January 1960 —31st December 1961			Excess of births
				IN	OUT	NET	
9.2	28	Janakkala	12734	657	531	126	106
	29	Orimattila	13683	631	689	—58	60
	30	Kärkölä	5798	360	442	—82	25
	31	Renko	3050	93	168	—75	13
			35265	1741	1830	—89	204
				49.4	*51.9*	*—2.5*	*5.78*
9.75	32	*Hämeenlinna*	28293	1951	1691	260	290
	33	Vanaja	6576	464	456	8	49
	34	Tammela	7679	217	390	—173	11
	35	*Forssa*	10736	707	534	173	97
			53284	3339	3071	268	447
				62.6	*57.6*	*5.0*	*8.39*
10.3	36	*Lahti*	65402	4362	3301	1061	646
	37	Hollola	10334	683	666	17	32
	38	Nastola	7747	588	496	92	40
			83483	5633	4463	1170	718
				67.5	*53.5*	*14.0*	*8.60*
11.2	39	*Heinola*	10851	1125	721	404	105
				103.7	*66.5*	*37.2*	*9.68*
		Grand Totals	938398	67589	50226	17363	8185

The field variates

As already mentioned, concurrently with the construction of the tables, the observed values are plotted. This keeps the operator constantly informed of the shape the graphed dependence is going to approach when an eventual inclusion of a commune is tested. In this connexion it was found best to let the positive square-root of central distance serve as the current co-ordinate of the independent (x) variate against which the observed y-values are plotted.

The march of all lines suggested by the observed points is in this study curved and nearly like the wave-form. Thus the present plots exhibit one peak and one trough, but some analoguous earlier cases have shown that their number may be double that quantity (*v.* AJO, 1954 *pp.* 159—161). This circumstance strongly discourages us from fitting a curve with a theoretically given number of turning-points. Thus the polynomials are left out although

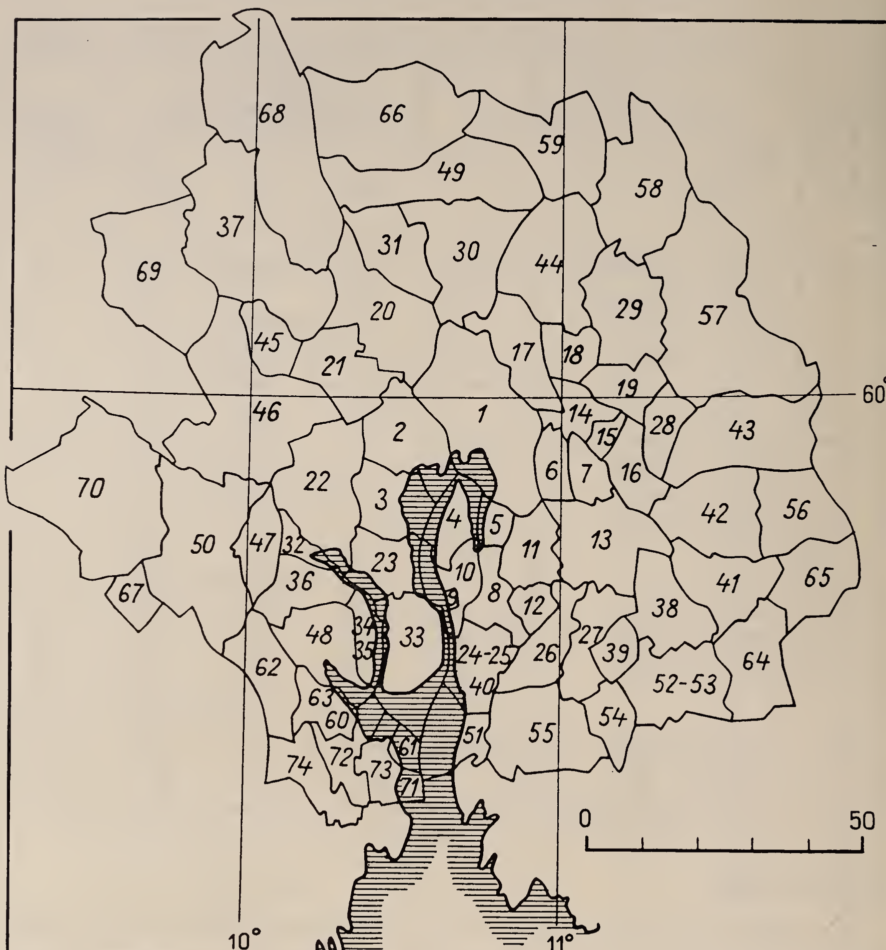


Figure 2. The Field of Oslo.

they might accurately represent the data (*v. infra*). Instead, the fitting of sinusoids seems to be advisable. This was already suggested by the earlier findings. The general form of the sinusoids here in view is given by

$$y = a + bx + R\sin wx \tag{1}$$

Weighted regressions

A tentative fitting soon attracts attention to some exceptionally great deviations. Because this happens in classes with relatively small populations, it is considered appropriate to carry out the curve-fitting by minimizing the

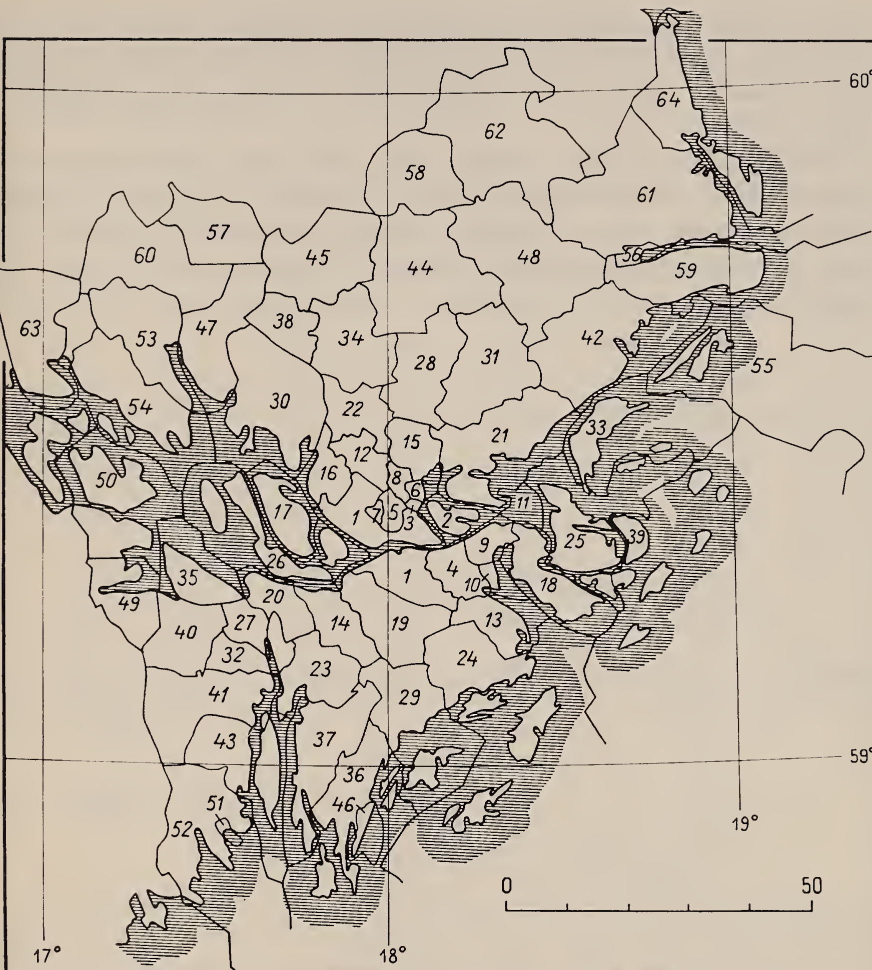


Figure 3. The Field of Stockholm.

weighted sum of squares of residuals, the weights being equal to thousands of inhabitants in the pertinent classes. By this means all observed points come to have their rightful influence upon the result.

Making use of matrix notation and running off the iterated sets of normal equations on an electronic computer, the parameters of best sinusoidal fit were obtained (*v.* Table 4).

The respective graphs of the interdependences considered are shown in Figs. 5—7. In order to highlight the need for and effect of weights used each

observed point is surrounded by a circle with an area proportional to the appropriate weight. The statistical bounding or most distant limit is likewise shown therein, whereas the geographical bounding is represented in Figs. 1—4.

Norwegian and Finnish statistics give the annual migration flows as numbers of in- and out-migrants. The net numbers of migrants are really thereby also given either implicitly (Norway) or explicitly (Finland). This results in much more information represented by more observed points than is given by the statistics of the figures of gross change alone. On the other

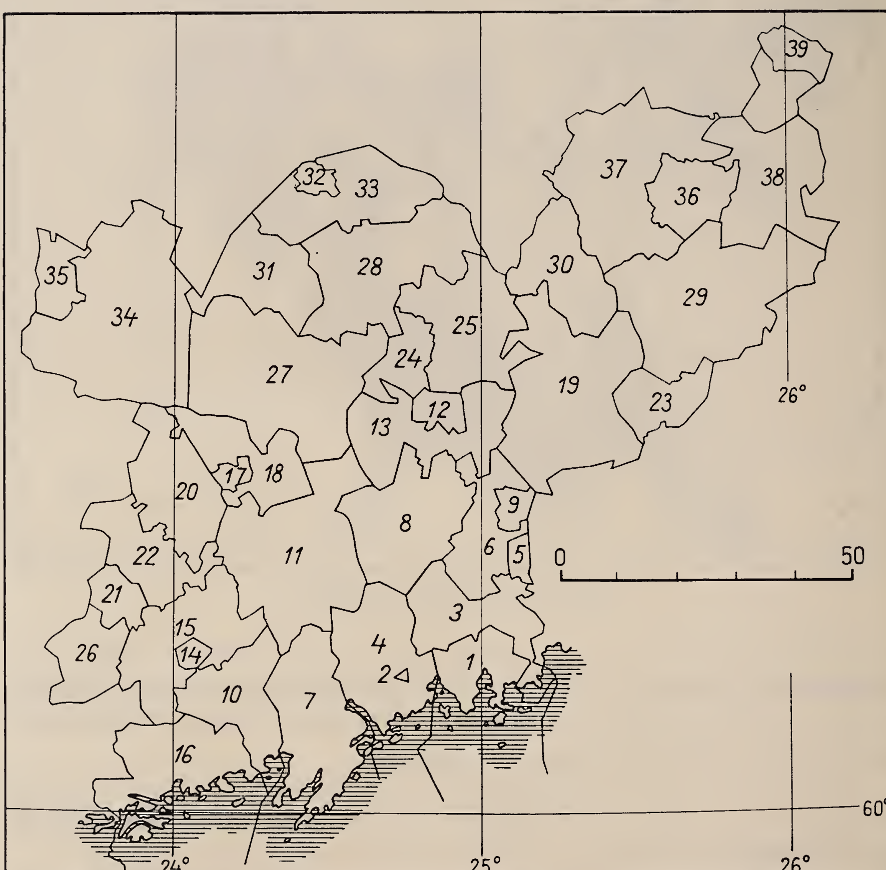


Figure 4. The Field of Helsinki.

Table 4. The results of curve fitting.

Field	Function	Parameters a	b	R	w	Residual Sum of Squares	Av.
Oslo	y_I	42.42	5.53	38.60	0.62	1789	1.85
	y_O	33.78	5.32	23.80	0.62	3884	4.02
	y_N	8.64	0.21	14.80	0.62	7299	7.54
						12972	13.41
	y_E	3.57	1.34	7.01	0.62	526	0.54
	y_G	12.21	1.55	21.81	0.62	13498	
Stockholm	y_G	5.25	3.27	71.04	0.48	15537	11.28
Helsinki	y_I	53.65	7.93	77.50	0.52	30190	32.82
	y_O	41.54	4.11	25.00	0.52	30907	33.59
	y_N	12.11	3.82	52.50	0.52	38298	41.63
						99396	108.04
	y_E	7.34	0.63	6.80	0.52	1079	1.17
	y_G	19.45	4.45	59.30	0.52	100475	

hand, the more detailed statistics mentioned above also introduce constraints. Thus it is required that

$$y_I - y_O = y_N$$

which implies, in case of sinusoids, that

$$w_I = w_O = w_N = w$$

The constraints evidently may impair the fit a particular component could otherwise obtain, as is seen in the graph representing y_O of Helsinki. In Fig. 7 the best individual fit of y_O is shown dashed. The aggregate best fit consistent with the imposed constraints, however, does'nt take heed of the particular closest fit. The weighted sums and averages of squared residuals obtained in the fitting process are shown in Table 4.

The excess of births (y_E) and the net migration (y_N) add up to the total calculated change of population (y_G), as shown in the table just mentioned.

Conclusions

The regressions thus obtained bring up a new and, with a view to future studies, a decidedly important feature in the variation considered, *i.e.* the fact that all regressions are curvilinear and of the same form. Thus the re-

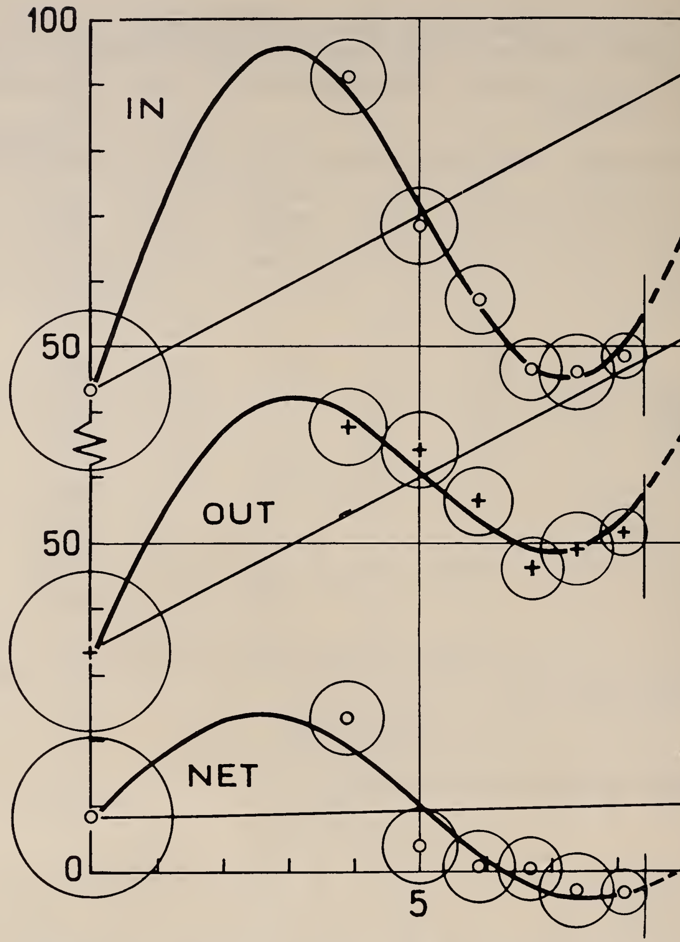


Figure 5. The Sinusoids of Closest Fit to the Data for Oslo.

spective equations have got the same form wherein the included parameters determine the individual characteristics of each particular regression.

In the earlier studies (*v.* Ajo, 1962) it seemed as though the regressions y_O and y_E consisted of only the straight-line component, the trigonometric term being absent or only insignificantly differing from zero. Its values have all too easily become mixed up and lost in statistical disturbance, *i.e.* noise, where it has escaped unnoticed. Such formal degeneration of sinusoidal into linear regression may be said to take place when the respective parameter $R \rightarrow 0$. In the present study this clearly is not the case, whence we conclude

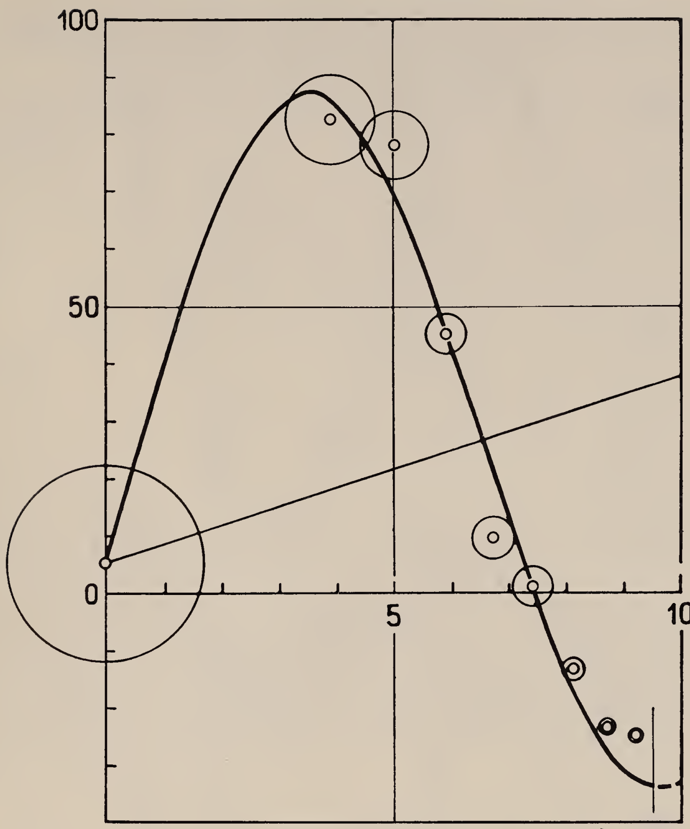


Figure 6. The Sinusoid of Closest Fit to the Data for Stockholm.

that the trigonometric term really belongs to the general form of the regressions under discussion (*supra* Eq. 1).

Another point of consequence is the observation that the regressions considered do not necessarily represent curves of the closest fit either individually or in the aggregate determined by the set constraints. To illustrate this, let us fit polynomials, *i.e.* expressions of the form

$$y = a_0 + a_1x + a_2x^2 + \ldots + a_px^p$$

to the same data as the three uppermost lines in Table 4. The required coefficients as well as the weighted sums of squared residuals are run off on the computer and shown in Table 5.

The fit of these curves is evidently a good one, when deemed wholly by the smallness of the residual variance which is here smaller than in the case

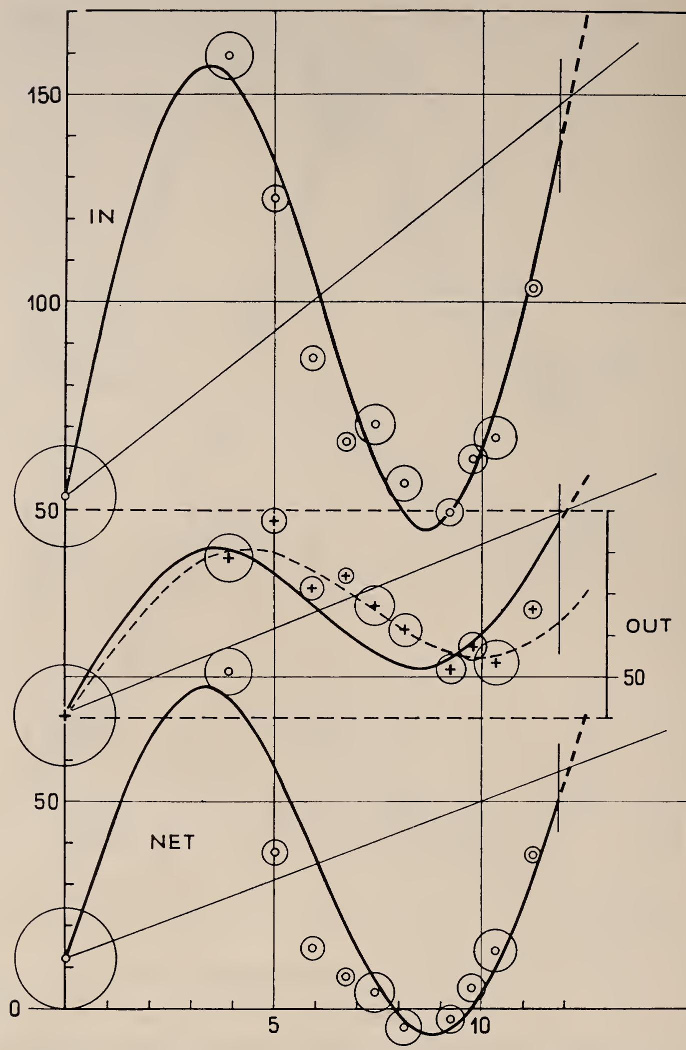


Figure 7. The Sinusoids of Closest Fit to the Data for Helsinki.

of sinusoids. None the less, even if their fit within the fitting range is ever so good, the author still does not suppose that the polynomials describe the subject interdependence generally, *i.e.* also outside their actual fitting range. For such expected results there certainly is no coverage, whereas the sinusoids, for reasons already partly referred to, are more likely to apply generally. This

Table 5. Cubic and Quartic Parabolas fitted to the same data as the three uppermost lines in Table 4.

Parabolas for Oslo: y_I, y_O, y_N		a_0	a_1	a_2	a_3	a_4	Residual sum of squares
Cubic	I	42.41	54.94	—14.97	1.03	—	1370
	O	33.68	30.54	—7.30	0.47	—	2789
	N	8.73	24.40	—7.67	0.56	—	*5457*
							9616
Quartic	I	42.40	76.17	—26.20	2.94	—0.106	666
	O	33.70	—1.52	9.67	—2.43	0.160	1183
	N	8.70	77.69	—35.87	5.37	—0.265	1017
							2866

conception may find some theoretical backing, and the author hopes to be able to return to this theme, soon.

Lastly, let it be mentioned that the fields of Oslo, Stockholm, and Helsinki, as here delimited, have about 0.97, 1.31, and 0.94 million inhabitants. The corresponding land areas are approximately 12.6, 8.4, and 9.7 thousand square kilometres; their average population densities are about 77, 156, and 97 persons per square kilometre, respectively.

LITERATURE

AJO, REINO, 1951. New aspects of geographic and social patterns of net migration rate. — *Lund Studies in Geography*, Ser. B. No. 13. Lund, Sweden.

—»— 1962. An approach to demographical system analysis. *Economic Geography*, Vol. 38, No. 4. Clark University, Worcester, Mass., U.S.A.

ERRATA

Acta Geographica 17, no. 4

Page 10, Fig. 2., for »2 = Caledonian schists» read »2 = Karelian schists».
Page 11, line 15, for »Aa far as» read »As far as».

ACTA GEOGRAPHICA
17

Text 127 pages, 24 figures in the text.